Managing Our Watersheds

A Systems Approach To Maintaining Water Quality
From the Editor

The theme of this year’s National Onsite Wastewater Recycling Association conference is the future of water quality. Here at the Clearinghouse, that is our overriding concern. Science can help mankind raise crops and livestock in greater quantities than ever before, but our supply of water is finite. It has been fixed since the formation of the oceans, and we will never get any more.

Good science and its managed application is the key to water quality. The tried and true septic system and any of the alternative treatment technologies will effectively treat wastewater in the optimum site conditions for that system; however, only research conducted with full application of the scientific method (p. 12) can determine what those conditions are.

It is with this in mind that we decided to get back to basic earth science in this issue and re-examine the hydrologic cycle, that natural process that moves water from clouds, through the earth, to the oceans and lakes, and then back to the clouds. In this discussion, we can place the importance of maintaining high-quality wastewater treatment in its proper perspective (p. 16). Recently, 31 states rated failing septic systems as their number two source of groundwater pollution (p. 4).

Good management is vital to the success of wastewater treatment technologies. The home aerobic treatment unit, for instance, consists of an air compressor and often a chlorination unit. Studies have shown that when these systems are properly sited and maintained, they can consistently treat wastewater to safe contaminant levels (p. 9). If they are improperly maintained, they can fail (p. 38).

Seeing that state regulators get the resources required to establish scientifically based laws and guidelines is one of the greatest challenges that needs to be faced to ensure quality onsite wastewater treatment across the U.S. At the NSF-sponsored second annual onsite wastewater state regulators conference this year (p. 24), regulators commented that, underfunded and understaffed as they are, they often have to contend with bureaucracies that either lack the funds to verify new technologies or will not pay for scientific studies. They are often forced to rely on what information they can get from each other and set rules “by the seat of our pants.”

Unfortunately, the NSF cannot funnel funds to state agencies, but we can supply information. This year has seen a bumper crop of new products, such that our entire Resource section has been devoted to them. We are also always on the lookout for new data for our databases, particularly the results of recent research. If you have it, please send it in. We know who needs to see it.

Listserv Available for NSFC News

The National Small Flows Clearinghouse (NSFC) recently established a listserv to send out wastewater-related press releases via e-mail. If you would like to receive news about free and low-cost wastewater-related products, you can now subscribe to this electronic mailing list. This service is for notification only and cannot be used for posting messages.

If your organization produces a wastewater-related newsletter, we would appreciate having the name and e-mail address of the editor to add to this listserv as well.

To subscribe, send e-mail to macjordomo@mail.estd.wvu.edu. In the body of the e-mail, type the message below with your first and last names and spaces where indicated. (Please note that this message must be in the body of the e-mail and not in the subject line or the server won’t recognize it.)

subscribe nsfcnews Firstname Lastname
A Survey of Home Aerobic Treatment Systems Operating in Six West Virginia Counties

This article summarizes the results of a 1998 survey of home aerobic treatment unit (ATU) systems in West Virginia. ATU systems (treatment unit plus chlorination) in six counties were evaluated to determine whether they were meeting health and environmental regulations. Data from the study will be used to guide state policy with regard to the monitoring of ATUs on existing sites and the permitting of ATUs for use in new construction sites.

Update on EPA’s Draft Guidelines for Management of Onsite/Decentralized Wastewater Systems

Joyce Hudson

This article is a follow-up to a column in the spring issue that introduced the U.S. Environmental Protection Agency’s (EPA) Draft Standards for Management of Onsite/Decentralized Wastewater Systems. The EPA now refers to them as guidelines, and this article reports recent changes to the draft, highlights reasons for development of the guidelines, and describes the proposed model management levels.

Managing Our Watersheds

A Systems Approach to Maintaining Water Quality

Patricia Miller, Ph.D., and Anish Jantania, Ph.D., P.E.

This article is based on one published in the October 1993 issue of Small Flows. The authors have revised it to reflect new developments and new perspectives that have occurred in the intervening years as they discuss the science, philosophy, history, and role of small wastewater flows in watershed management.

State Regulators Gather in Colorado

Second Annual Onsite Wastewater State Regulators Conference.....Harriet Emerson

Where Sheep Do Quietly Graze

Innovative Wastewater Treatment in the Great Northwest.....Natalie Eddy

Vacuum Sewer Technology Comes of Age.....Cathleen Falvey

Practical Pointers for Onsite System Inspectors.....Patricia Miller
Letters to the Editor

Dear Editor:

Thank you for the “introductory article” on Native Americans (as you called it in “From the Editor”) in the Summer 2000 issue of Small Flows Quarterly. You may be able to render a great service in providing information in several directions to the benefit of all. These directions would be to Native American people, to others who are ignorant of conditions in “Indian Country,” and to government agencies and staff people who may “think in a box” and rarely be pressured to think outside the parameters of their boxes. (It is when we are pressured, internally or externally, to do some creative thinking that we become innovative.)

Beware of generalities, please, when speaking or writing about Native Americans. We are not all alike in our conditions, our expectations, our attitudes, or our geographies, any more than are rural communities across the U.S. and Canada.

May I make a few more observations? Your article by Natalie Eddy was pretty good. Congratulations. You are stepping forward and leading the way.

Your map of “Today’s Indian Reservations” is poor because a) it is tiny, and therefore, hard to read; b) it is not well-defined (so that it appears some reservations are not shown at all, and some “spots” on the map look like they are supposed to be reservations and they are not); and c) it is therefore not accurate. There are many small reservation lands (called “reserves” in Canada), and the

CONTINUED ON PAGE 50

States Rate Septic Tanks as No. 2 Source of Groundwater Pollution

In a recently published U.S. Environmental Protection Agency (EPA) report, 31 states listed septic systems as their second greatest potential source of groundwater contamination. Leaking underground storage tanks headed the list.

This document, the National Water Quality Inventory: 1998 Report to Congress, is the twelfth biennial report to Congress and the public about the quality of U.S. rivers, streams, lakes, ponds, reservoirs, wetlands, estuaries, coastal waters, and groundwater. It was prepared under Section 305(b) of the Clean Water Act (CWA), which requires states and other jurisdictions to assess the health of their waters and the extent to which they meet state water quality standards and the basic goals of the CWA. This information is submitted to the EPA every two years and summarized in the biennial report to Congress.

States have not yet comprehensively assessed all of their waters, but this edition of the biennial report is based on the assessment of almost 25 percent of the nation’s total river and stream miles; 40 percent of its lake, pond, and reservoir acres; and 30 percent of its estuarine square miles.

This 1998 report represents the second 305(b) cycle of data collection based on groundwater guidelines introduced to states as part of the 1996 305(b) reporting cycle. The chapter on groundwater is the result of data submitted by 37 states, three territories, four tribes, and the District of Columbia (all collectively referred to as states). States reported groundwater-monitoring data for a total of 146 aquifers or hydrogeologic sitings.

The report concluded that while the quality of U.S. groundwater is good and can support the many different uses of this resource, aquifers across the nation are showing measurable impacts from human activities. Monitoring has detected elevated levels of petroleum hydrocarbon compounds, volatile organic compounds, nitrates, pesticides, and metals. Improperly constructed and poorly maintained septic systems are believed to cause substantial and widespread nutrient and microbial contamination to groundwater.

The significance of this to the environment as a whole can be seen in the results of a U.S. Geological Survey study (cited in the report) that included at least 2 streams in each of 24 physiologic and climatic regions nationwide to investigate groundwater and surface water interactions. Based on daily stream flow values for the 30-year period 1961 to 1990, the analysis indicated that an average of 52 percent of all the streamflow in the U.S. was contributed by groundwater. This contribution ranged from 14 to 90 percent. Historically, surface water and groundwater have been treated as separate entities in the management of water resources.

The National Water Quality Inventory: 1998 Report to Congress can be read or downloaded from the EPA’s Web site at www.epa.gov/305b/98report/index.html. Most of the files are in PDF format. These include the following:

• a two-page summary (HTM L, PDF, 25k),
• The Quality of Our Nation’s Waters (brochure) (PDF, 257k),
• full report by chapter,
• individual fact sheets, and
• appendices from the National Water Quality Inventory.
Calendar of Events

OCTOBER

Solutions for Small Community Wastewater Management II
National Rural Electric Cooperative Association
October 4–6
Minneapolis-St. Paul International Airport, Minnesota
Johnny Latimer (703) 907-5916

Eighth International Symposium on Animal, Agricultural and Food Processing Waste
The Society for Engineering in Agricultural, Food, and Biological Systems (ASAE)
October 9–11
Des Moines, Iowa
Johnny Latimer (703) 907-5916

WETTEC 2000 73rd Annual Conference and Exposition*
October 14–18
Anaheim, California
(800) 666-0206
(703) 684-2452
www.wef.org
coninfo@wef.org

NALMS 2000: Celebrating 20 Years of People Linking Lake and Watershed Management
North American Lake Management Society
November 8–10
Miami, Florida
(727) 464-4425
Pamela Measure
pleasure@co.pinellas.fl.us, or
nalms@nalms.org

Wetlands Regulatory Workshop
U.S. Environmental Protection Agency
October 29–November 2
Atlantic City, New Jersey
Ralph Spagnolo (215) 814-2718

Healthy Watersheds: Community-Based Partnerships for Environmental Decision-Making Seminar
U.S. Office of Personnel Management
October 30–November 10
Aurora, Colorado
Phyllis O'Meara (303) 671-1034

NOVEMBER

Facilitating and Mediating Effective Environmental Agreements
CONCUR, Inc.
November 8–10
Berkeley, California
(510) 649-8008
www.concurinc.com

Ground Water: A Transboundary, Strategic, and Geopolitical Resource
Association of Ground Water Scientists and Engineers
December 1–4
Reno, Nevada
Terry Thiessen (608) 233-2836
thiessen@nalms.org

North American Lake Management Society’s Symposium
National American Lake Management
December 1–4
Pittsburgh, Pennsylvania
Michael E. Campana
(505) 277-3269
aquadoc@umn.edu

DECEMBER

Integrated Decision Making for Watersheds Symposium
U.S. Environmental Protection Agency
January 7–9
Chevy Chase, Maryland
Kim Devonald (202) 564-5178
devonald.kim@epa.gov

Ninth National Symposium on Individual and Small Community Sewage Systems*
The Society for Engineering in Agricultural, Food, and Biological Systems (ASAE)
March 11–14
Fort Worth, Texas
David M. Gustafson
(800) 955-8636
Fax: (612) 625-1263

MARCH

Alternative Water and Waste Technologies for Small Communities Conference
The Nebraska Department of Environmental Quality’s Nebraska Environmental Partnerships
March 28–29
Omaha, Nebraska
M.J. Rose, Coordinator
(402) 471-3193

APRIL

Small Drinking Water and Wastewater Systems*
NSF International
April 22–25
Washington, D.C.
(734) 827-6818 (for abstract submission)
(734) 827-6865 (for drinking water program information)
(734) 827-6865 (for wastewater program information)

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NOWRA Names New Executive Director

The National Onsite Wastewater Recycling Association (NOWRA) recently named former U.S. Environmental Protection Agency (EPA) Municipal Technology Branch Chief, Robert E. Lee, as its new executive director. Lee will work with NOWRA through an intergovernmental personnel agreement with EPA. NOWRA also selected Dr. Linda Hanifin Bonner of Hanifin Associates, Laurel, Maryland, as its new associate director. The change follows the retirement of former Executive Director Pam Franzen and the departure of Associate Director Jon Shulman.

Both Lee and Bonner have a broad understanding of wastewater systems and issues. Lee directed the development of the influential 1997 EPA document Response to Congress on the Use of Decentralized Wastewater Treatment Systems. While at EPA, he recognized NOWRA’s potential as a leader in moving onsite and decentralized wastewater treatment into the mainstream of America’s wastewater infrastructure. Bonner is a nationally recognized water quality expert who specialized in helping water quality and wastewater officials understand the needs of the public.

The new management team’s primary objective will be “to place NOWRA in the national spotlight as the premier organization for the onsite wastewater industry.” They also plan to advance the NOWRA vision as outlined in the seven elements of the organization’s Model Framework for Unsewered Wastewater Infrastructure, July 1999. An important focus will be on performance requirements.

For more information about NOWRA, contact them at their new headquarters at 632 Main Street, Laurel, Maryland 20707, (800) 966-2942, or visit their Web site at www.nowra.org.

Total Maximum Daily Load Rule Finalized

On July 11, 2000, the U.S. Environmental Protection Agency (EPA) issued the final total maximum daily load (TMDL) rule. The rule was originally proposed in August 1999 and has been modified following stakeholder comments. Its purpose is to improve implementation of the TMDL program, enabling EPA to better work in partnership with state and local governments to develop solutions for cleaning up the 40 percent of U.S. waterways that presently do not meet public health protection goals.

Under the revised TMDL program, states will develop more comprehensive lists of polluted waterbodies than was required previously. Lists will be developed every four years. Clean-up plans will be developed within 10 years; an additional five years will be allowed if needed. As these plans are being developed, higher priority will be given to polluted waters that are sources of drinking water or that support endangered species. A list of actions needed to reduce pollutant loadings and a timeline for implementation will be developed. To provide reasonable assurance that implementation will occur, a monitoring plan and milestones to measure progress also is planned.

The final TMDL rule differs from EPA’s original proposal in a number of areas. These changes are in response to a large number of comments received following the initial proposal. In general, the changes provide the states with increased flexibility in implementing the program. These changes include: dropping provisions that could have required new permits for forestry, livestock, and aquaculture operations; saving states four years instead of two years to update inventories of polluted waters; and allowing states to establish their own schedules for when polluted waters will achieve health standards, not to exceed 15 years.

A copy of the final rule and a fact sheet are available from the EPA Web site at www.epa.gov/owow/tmdl/finalrule/. For more information, you may contact Jim Pendergast at (202) 260-9549 or Kim Kramer at (202) 260-7933.
provides access to BMP performance data in a standardized format for more than 70 BMP studies conducted over the past 15 years. The database may be searched on this Web site, and is also available on CD-ROM. Additional BMP studies are currently being prepared for the database, which was developed by the Urban Water Resources Research Council (UWRC) of ASCE under a cooperative agreement with the U.S. Environmental Protection Agency (EPA).

National Biosolids Partnership
www.biosolids.org

The National Biosolids Partnership (NBP), a nonprofit consortium of the Water Environment Federation (WEF), Association of Metropolitan Sewerage Agencies, and the EPA, seeks to advance environmentally sound and accepted management practices for biosolids, the nutrient-rich organic product of wastewater treatment. The Web site is a central clearinghouse for communication of biosolids-related information and contains numerous links to WEF member associations, regional biosolids organizations, trade groups, and state and federal regulatory agencies. Navigational tools include a home page map of the U.S. with links to each of the 10 EPA regions as well as individual Web pages for each of the 50 states. Visitors are able to access contacts and survey results specific to their state and region.

A communications feature of the site enables rapid dissemination via e-mail of news stories. Other features include technical documents, a calendar of events, opportunities for technical information exchange, and links to free Internet ad e-mail for those without these services.

Wastewater Discussion Board Is Back Online

Do you want to talk about wastewater? The National Small Flows Clearinghouse (NSFC) now provides an online discussion group for professionals and other individuals with an interest in small community wastewater issues. The discussion board is located at www.estd.wvu.edu/forum/nsfc. This forum is open to anyone wishing to post wastewater-related questions and receive feedback from users.

In addition, there is an online National Onsite Demonstration Program (NODP) discussion group for those involved with demonstrating the use of onsite/alternative wastewater technologies. You can access the NODP Discussion Group at www.estd.wvu.edu/forum/nodp.

If you have specific questions that require the expertise of an engineer, we encourage you to call the NSFC at (800) 624-8301 or (304) 293-4191 and ask to speak with a technical assistance specialist.
Quality Maintenance Key to ATU Performance in Texas

A report released by the Harris County Public Infrastructure Department (HCPID) in Texas documents that aerobic treatment units (ATUs) in that county perform as well in the field as they did during National Sanitation Foundation (NSF) Standard 40 testing. The field performance of ATUs has been questioned for years, with numerous reports of units performing poorly.

“After comparing the results, it is apparent that the home aerobic units do perform as well in the field as they did in the test facility provided proper maintenance procedures and routines are followed,” said John Blount, P.E.

The first surface irrigation ATU was installed in the county in 1989. (There are more than 2,500 now.) Until that time, sites with tight clay soils usually had either evapotranspiration beds or inadequate conventional systems installed. Harris County has been keeping detailed records on surface irrigation ATUs since then.

These records include the current maintenance contractor, when the maintenance reports are due, and when biochemical oxygen demand (BOD) and total suspended solids (TSS) testing is required. The county requires annual testing and quarterly site visits by maintenance contractors. The actual test results, however, are not recorded, so in order to evaluate the performance statistically, the office chose one maintenance contractor and reviewed his records.

“We chose this company because they are an independent maintenance company that does not install systems or have a specific manufacturer’s association,” Blount said. “We reviewed the results of 140 samples. The average BOD result was 12.6 milligrams per liter (mg/L) and the TSS result was 9.6 mg/L. These are grab samples, for which the state regulations allow up to 65 mg/L of BOD and TSS.”

Only two samples exceeded the grab sample standard. According to these results, 98.5 percent of the samples complied with the state standard.

The HCPID obtained additional data for 103 systems from a second independent maintenance contractor, and those results were very similar, said Blount.

The Trinity River Authority also supplied a significant amount of data from 116 systems for BOD and TSS results. The average for all systems tested were a BOD of 19 mg/L and a TSS of 19. Five percent of these samples exceeded either the BOD or TSS grab limitations of 65 mg/L.

“This data has been categorized by both brand of aerobic unit and by maintenance contractor,” said Blount. “Significant differences can be seen in both categories. The interesting feature when comparing data between all three sample groups is that who maintains a unit type significantly alters the outcome of results. In one group, the average BOD of one particular brand is 10 times the average of the same brand in another group.”

The engineer’s office compared these three data sets to a sampling of NSF test results and concluded that the ATUs in the field perform consistently within the standard and similar to NSF Standard 40 predictions.

“Clearly,” said Blount, “if a tested unit is installed and operated properly, the single most important factor to continued proper operation is quality maintenance. Several reports have surfaced showing poor ATU performance; however, we have seen none that show this if the system is properly installed, operated, and maintained.”

For more information about the study or ATUs in Harris County, Blount can be reached at the HCPID at (713) 956-3015 or jblount@eng.hctx.net.

An aerobic treatment unit (ATU) treats wastewater using natural processes that require oxygen. Most ATUs include a pretreatment step to reduce the amount of solids entering the aerobic unit. This pretreatment step could be a septic tank, primary settling compartment as part of the ATU, or a trash trap. Wastewater then enters the aeration compartment of the ATU where an air blower or compressor mixes air (oxygen) with the wastewater. Aerobic bacteria break down and remove some of the solids. Remaining solids are then allowed to settle out prior to the next treatment step. Depending on the design of the system, settling of solids may occur in a separate compartment or be allowed to accumulate in the bottom of the tank and may need to be pumped out periodically. Further treatment and/or disinfection is needed prior to final dispersal back into the environment.
Texas Environmental Health District Begins Automated Chlorination Program for ATUs

In the rapidly growing region north of Austin, Texas, the Williamson County and Cities Health District has developed a strategy to allow new home aerobic wastewater treatment units to be installed and used as long as homeowners properly disinfect the wastewater. But, when they cease to disinfect effluents, the systems automatically shut off.

“For many years, we’ve been discussing ways to make sure that chlorine is regularly being applied,” says Paulo Pinto, who manages the onsite wastewater program for the Williamson County Health Department. “We know that people don’t want to put chlorine in the tube. It’s a nasty job. But we also know that failing to add chlorine will mean that effluents that have not been disinfected will be applied to the environment. This tool will help us make sure that new systems produce and apply only disinfected effluents.”

The system is relatively simple. Once every 12 hours, an electronic monitoring device weighs the content of tubes where chlorine tablets are inserted. When the weight of a tube indicates that it contains fewer than two chlorine tablets, the pump automatically shuts off, preventing any effluent from being irrigated. At the same time, a buzzer sounds and a blue light begins flashing, loudly telling the homeowner that a problem exists. In addition, the monitoring system also is activated if a pump or compressor fails, thus making the unit unable to produce secondary treated effluent.

When a problem is detected, the system automatically dials one of a number of local companies that monitor these aerobic systems and informs them that the unit is low on chlorine. It is then up to the monitoring company to contact the operation and maintenance company with which the homeowner has contracted. This system adds less than $200 to the cost of most aerobic treatment units.

If the problem can be fixed within two days, Pinto says no criminal charges are typically filed by the Williamson County and Cities Health Department unless the homeowners have routinely failed to put chlorine in their system. If it lingers beyond two days, the case may be referred to a justice of the peace as a public health nuisance. Even if no legal action results, a homeowner’s failure to simply add a chlorine tablet will bring about the cost of a visit by their maintenance company. In most cases, the minimum expense is at least $40 per visit. If the family chooses to ignore the problem, treated wastewater will start to back up inside of their home because it can’t be safely disposed of through land application.

Similar efforts have been started by other regional management agencies, including the Lower Colorado River Authority, the Brazos River Authority, and the Bastrop County Health Department.

For more information about this program, contact Paulo Pinto at ppinto@wilco.org. For more information about onsite wastewater systems and programs in Texas, visit the Texas Water Resource Institute Web site at http://twri.tamu.edu.

By Ric Jensen, editor of the newsletter Texas On-Site Insights at Texas A&M University (RJensen@twri.tamu.edu or http://towtrc.tamu.edu).
In the Spring issue of Small Flows Quarterly, I introduced you to the U.S. Environmental Protection Agency’s (EPA) Draft Standards for Management of Onsite/Decentralized Wastewater Systems. In this article, I would like to update you on recent changes to the draft, highlight some of the reasons for EPA’s development of the guidelines, and describe the proposed model management levels in some detail.

The purpose of the guidelines (formerly “standards”) is to raise the performance level of onsite/decentralized wastewater systems through improved management programs. EPA proposes to promote improved management by establishing national guidelines that raise the quality of management programs, establish minimum levels of activity, and institutionalize the concept of management. The guidelines will help communities meet water quality and public health goals and provide a greater range of options for cost-effectively meeting wastewater needs.

The proposed management guidelines have attracted a high level of interest, and we continue to receive significant input from numerous stakeholders, including regulators, environmentalists, engineers, and service providers. We have changed the title from “standards” to “guidelines” to emphasize that they are not federally mandated. On the other hand, we have added language to highlight the serious water quality impacts resulting from lack of management, and have identified specific circumstances where high levels of management are strongly encouraged. The guidelines are undergoing final internal review, and a notice will soon be published in the Federal Register, which will be followed by a 60-day public commenting period.

While it is difficult to measure and document specific cause-and-effect relationships between onsite systems and the quality of our water resources, there is little doubt that improperly operating systems are significant contributors to major water quality problems. States report failing septic systems as the second most important source of groundwater contamination.

In a recent survey of ocean beaches, EPA reported that septic systems were a significant pollution source for more than one-third (36 percent) of the water-quality impaired miles of shoreline. The discharge of partially treated sewage from malfunctioning septic systems was identified as a principal or contributing factor in 32 percent of all harvest-limited shellfish growing areas, resulting in considerable economic impact on the shellfish industry.

Onsite wastewater systems have also added to the overabundance of nutrients in ponds, lakes, and coastal estuaries, leading to over-growth of algae and other nuisance aquatic plants. Septic systems are a factor in the contamination of drinking water sources. EPA estimates that 168,000 viral and 34,000 bacterial illnesses occur in the U.S. each year as a result of drinking water systems that rely on groundwater. Malfunctioning septic systems are identified as one potential source of this contamination.

Due to water quality concerns on a national scale, EPA is recommending that a basic level of management of onsite systems be achieved in all cases, and that the highest levels of management be implemented in cases where there is high risk of environmental degradation or a threat to public health, particularly where onsite systems

<table>
<thead>
<tr>
<th>Model Program</th>
<th>Typical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Areas where conventional onsite systems are adequate to protect water quality and public health.</td>
</tr>
<tr>
<td>2</td>
<td>Areas where sites are marginally suited for conventional systems, requiring alternative, enhanced treatment systems to be implemented.</td>
</tr>
<tr>
<td>3</td>
<td>Moderately environmentally sensitive areas that require engineered designs to meet specific performance requirements based onsite characteristics.</td>
</tr>
<tr>
<td>4</td>
<td>Areas where there is existing or potential impairment of receiving waters, and the environmental and technology concerns require greater assurance of adequate operation and maintenance.</td>
</tr>
<tr>
<td>5</td>
<td>Existing or potential impairment of highly sensitive areas such as sole source aquifers, critical aquatic habitats, outstanding natural resource waters, or other areas where highly centralized management is needed to ensure reliable, long-term system operation and maintenance.</td>
</tr>
</tbody>
</table>
are identified as a significant source of water quality impairment.

The guidelines present five incremental levels of management in a progressive series of “model programs,” beginning with basic information collection and maintenance awareness, and moving up to the highest level of management, in which onsite systems are owned and managed by a utility. Each of the model programs shares the common goal of ensuring protection of human health and the environment. Each model program includes a set of management objectives, and an accompanying set of associated elements and activities targeted at the satisfactory achievement of the objectives. Program elements include planning, siting, design, construction, operation and maintenance, residuals management, certification and licensing, education and training, inspections, monitoring, and record keeping.

The model programs are a benchmark for a state, tribal, or local unit of government to 1) identify its management objective, 2) evaluate whether or not its current program is adequate, and 3) determine both an appropriate management program and the necessary program enhancements to achieve its management objectives and public health and environmental goals. EPA recognizes that states, tribes, and local governments need a flexible framework and guidance to best tailor their programs to the specific needs of the community and to the institutional capacity of the regulatory authority. These model programs are not intended to supersede existing federal, state, tribal, and local laws and regulations, but rather to complement them. The following is a discussion of the various recommended levels of management, which are summarized in table 1.

- Model Program 1—System Inventory and Awareness of Maintenance Needs: EPA recommends this as a minimum level of management. Model Program 1 applies where conventional onsite systems, owned and operated by individual homeowners, are sited in areas of low environmental sensitivity.
Small Flows Quarterly
Fall 2000, Volume 1, Number 4

Science and Regulatory Decision Making

Onsite regulators and regulatory review panels across the country are evaluating a growing number of manufacturers’ requests for technology approvals. Technical support documentation from manufacturers ranges from peer-reviewed papers with attached third-party research reports to claims of “our system works just like Product X’s system” with little supporting third-party research.

At the same time, states and provinces are remaking their entire rules into more performance-based approaches. The growing environmental focus in onsite wastewater is causing a shift in emphasis from the traditional disposal aspect to more of the treatment aspect in rule revisions.

In this article, we discuss the role of science in helping make these decisions in the future. How should regulators decide about the amount and quality of data needed for a specific product approval request? What place should science have in the larger decisions regarding changing your town, county, state, or provincial rules? What role should other factors besides “pure” scientific studies play, as a practical matter, in regulatory decision making?

THE SCIENTIFIC METHOD

First, let’s review the components of the scientific method for conducting a research study. These go to the heart of science and are the pieces that make science work.

Literature Review and Problem Definition

Literature review involves a detailed assessment of the published scientific and nonscientific literature. As the literature review proceeds, the researcher begins to define the parameters of the problem.

Hypothesis

A clear definition of the problem helps the researcher develop the project objectives, and hence, the hypothesis to be tested. The performance of the systems of interest, say for example, the XYZ trench design, are usually compared experimentally to a control—for instance, the conventional trench—or to an industry or environmental standard. However, we hope you realize that our understanding of the conventional system is, itself, imperfect.

Methods

Note that the research methodology will be developed to control all outside influences, reduce bias, and focus upon the specific project hypothesis. Usually statistical levels of significance also will be defined.

Data Collection, Analysis, Results, and Discussion

Data are collected regarding performance of the treatments and the control. These data are then verified, analyzed, and tabulated, and results developed in the form of tables and figures with explanations. For field research, the methods are adapted and adjusted as the researcher goes from plans on paper to reality in the field.

Discussion places the “data set,” or results, in a meaningful context relative to the methods and the existing literature. Here, the potentials and limitations for extrapolation of the results to other environmental conditions are exposed.

Conclusions and Recommendations

The research conclusions follow naturally from the discussion of the results. The researcher summarizes the major findings that can be confidently supported by the data collected during the study. Conclusions from any one study are usually specific and not sweeping or broad unless other supporting studies are cited extensively, such as in a review paper regarding a technology.

Publication

Publication of the results is just as important as the research itself. Publication usually begins as a research report or thesis and then is refined or
Controlled Studies
The best research studies have a strong measure of control over outside variables, or factors, that could add “noise” to the data set. Otherwise, the researcher might not be able to discern the true impacts due to the treatments. Statistical designs and research methodologies are used to block out extraneous influences so that the research results will focus on the treatments of interest.

Intuitively, the side-by-side study protocol provides a high degree of experimental control. But, when properly done, the side-by-side protocol is expensive, can only be done at one or two sites, and must start from scratch with newly installed systems. Soil properties vary so substantially, even in one soil at one site, that there may well be more experimental variability within replications of any one treatment than between the treatments of interest.

Using our castle analogy, the degree of control in a study affects the internal strength of each building block. The better the control of extraneous environmental conditions, the more substantial and stronger is the building block.

Replication
Replication is the key to the size of the castle and hence the breadth and weight of the conclusions about a technology or a proposed rule that can be held up by the foundation. If relationships between the treatments and the control hold up consistently over many replications within an experiment or between different experiments under broader environmental conditions, then the study results are less likely to be due to random chance, and our conclusions become stronger.

Broad Ranging Environmental Conditions
The intensive, highly controlled type of side-by-side study is invaluable for providing clear results and conclusions about system performance at one site. However, the results cannot be easily extrapolated outside the narrow set of conditions tested during the study without additional data. Also, since the side-by-side research process takes quite a bit of time, it is not always the most efficient approach...
Burnett, Washington: From Straight Pipes to Alternative Onsite Systems

In 1998, 15 onsite wastewater systems in Burnett, a small, mined-out coal town southeast of Tacoma, Washington, were failing or malfunctioning. But innovation, hard work, and funding from a variety of sources have changed all that.

History of Burnett

When Burnett was built in the late 1800s, it became home to hundreds of coal miners and their families. The town was typical of many turn-of-the-century coal mining towns: its location was poorly chosen with marginal soils and a high water table, and straight pipes discharged sewage into local streams.

As the coal mine flourished, the town grew, adding a road, hotel, schoolhouse, and general store. This growth added to the pollution that already plagued local water sources.

Burnett closed its mine in 1921 and relocated its miners to another coal-mining town. Left behind were mine shafts, tunnels, cave-ins, old sewer lines, and cottages.

Current Demographics

The demographics have changed since Burnett was a thriving coal-mining town. No longer populated by young coal miners and their families, the town is home to many elderly couples, widows, and low- to middle-income workers. The average income is less than $30,000 a year.

Thirty families currently live in upper Burnett, and 30 homeowners live along the creek in lower Burnett. These people occupy the same cottages that were built in the late 1800s. Some of the cottages have been remodeled, but many remain in their original form and all of them are serviced by straight pipes or failing septic systems that harm the

Burnett Begins Its Journey of Change

In 1996, Burnett formed the Burnett Wastewater Disposal Task Force (BWDTF) which comprised community members from both Upper and Lower Burnett. Its purpose was to find solutions to Burnett’s onsite wastewater problems.

The task force applied for and received a $25,000 Physical Improvement Project grant from the Pierce County Department of Community Services. The grant was earmarked for assessing site conditions and exploring repair options.

Shortly after, Burnett received a $95,000 grant from the U.S. Environmental Protection Agency through the National Onsite Demonstration Program (NODP) Phase II, which is administered by the National Small Flows Clearinghouse in Morgantown, West Virginia.

“There are several communities around the country in similar situations that could use this demonstration project as an example of how to meet their domestic wastewater needs,” said NODP Phase II Program Coordinator Clement Solomon. “It is also a very valuable experience—as are all of the other Phase II projects—to bring to Phase V of the NODP, which focuses on Appalachia.”

“The members of the Burnett community are very excited about the NODP II project and are committed to work in any way possible to ensure the success of the project,” said Ron Smith, chairman of the Burnett Task Force. For example, BWDTF has volunteered to help restore landscaping, raking, seeding, monitoring, reading and recording meters every day, one hour a day over a one-year period.

“The NODP offers the ability not only to correct an egregious situation,
but to learn about the suitability of various treatment systems and their applications,” said Ladley.

The NO DP grant was used to design, install, maintain, and monitor the chosen systems. Should a system fail, it will be repaired from state revolving loan funds.

Both local and state regulatory people agreed that Burnett fit the national, state, and local criteria for NO DP II. The site is environmentally sensitive and problematic for traditional onsite sewage technology, providing an opportunity to use a variety of alternative systems.

In addition to NO DP’s criteria, the state added some criteria of its own for selecting a site. For example, the town had:
• some organizational structure,
• agreed that it had onsite problems,
• agreed to work together to solve the problems,
• agreed to allow all types of onsite wastewater treatment systems; and
• agreed to be used as a center for hands-on education for designers, installers, pumpers, and maintenance specialists since the town was less than a 45-minute drive from the National Onsite Wastewater Training Center in Puyallup.

“This is a perfect example of one of the NO DP’s core principles, which is the bottom-up approach,” said Solomon.

“The effort has to come from within the community for it to be successful.”

The Washington Department of Health awarded $75,000 to Burnett. The town used money from this third funding source for constructing, evaluating, and reporting findings for emerging or under-utilized onsite wastewater technologies.

Management Setup

WO SSA was the NO DP grant recipient, and WO SSA’s executive secretary was the contact person for the project. Project coordinators are Jerry Stonebridge, past president of WO SSA and current president of Stonebridge Construction Company, Inc., and Bill Stuth Jr., WO SSA board member and resource person. The Tacoma-Pierce County Health Department is the permitting agency, and the BWDTF provides field support with property owners.

CONTINUED ON PAGE 49

NODP V To Help Appalachia

The latest project of the National Onsite Demonstration Program (NODP) will place special emphasis on states within the Appalachian region. Called Phase V, this program will employ a variety of activities to promote the use of onsite, cluster, and community wastewater treatment technologies and management systems as viable alternatives to full central sewage systems for use in small communities and environmentally sensitive areas.

NODP Phase V will continue to build on the experiences of previous NO DP accomplishments. This project will focus on states included within the Appalachian region, due to three primary factors: 1) the isolation experienced by areas of these states due to mountainous topography, 2) the incidence of small, widely dispersed communities, and 3) the prevalence of poverty.

The Appalachian region runs through the center of 13 contiguous states, from New York to Georgia. Of these states, five (New York, West Virginia, Virginia, Kentucky, and Georgia) will participate in NO DP V.

The mountainous topography of the Appalachian region has, over the years, had an isolating effect on its people. Much of Appalachia consists of small communities or small settlements in rural areas with low average incomes. People living in these communities and rural settlements are often unaware of the health issues related to wastewater.

According to the Appalachian Regional Commission, “Topography and low population density often prohibit standard infrastructure development or make it prohibitively expensive. As a result, many areas of the region suffer from poor water quality and a shortage of wastewater treatment facilities.”

Projects carried out under the NO DP typically involve designing, constructing, implementing, maintaining, managing, and monitoring onsite wastewater treatment technologies. Project members provide relevant information and technical assistance to local officials and citizens, maximize efficiencies through partnerships, and assist in the creation of management districts. They also provide training and public education opportunities and disseminate information nationwide about NO DP accomplishments and results through a variety of means.

For information about NO DP V, call Program Coordinator Clement Solomon at (800) 624-8301 or (304) 293-4191.
Managing Our Water
Editor’s Note: This article is an update by the original authors of an article first published in the October 1993 issue of the Small Flows newsletter, the National Small Flows Clearinghouse publication which preceded the Small Flows Quarterly.

Why do we publish the Small Flows Quarterly? Why do we have a National Small Flows Clearinghouse? Why does anyone bother to treat wastewater—with septic systems, advanced onsite systems, or large municipal sewage treatment plants?

A fundamental answer to all of these questions is “water quality”: water quality for drinking water supplies; water quality that ensures public health and decent living standards; water quality for commercial, agricultural, and recreational uses; and water quality that supports the earth’s living organisms. Yet those of us who work with wastewater sometimes become so busy with the means—designing a sand filter, administering state revolving fund (SRF) dollars, revising state codes, publishing a newsletter—that sometimes we may forget the essential goal of protecting and restoring water quality. In light of federal and state activities promoting watershed and groundwater protection, maybe it’s time to dive into the basic subject of water so that we can better understand the role of decentralized wastewater in watershed management.

Water Cycle

Earth’s water is best described in terms of the water cycle, or hydrologic cycle, a system of continuous circulation of water from atmosphere to land (both above and below ground) to sea to atmosphere again. (See figure 1.)

Water moves upward into the atmosphere by evapotranspiration, a combination of evaporation from land and water bodies and transpiration from the leaves of plants. Water condenses in the atmosphere and falls back onto land and water surfaces as precipitation, rain, or snow. Precipitation can follow several pathways after it falls back onto the earth’s surface. It may fall onto an ocean or lake or other body of water and become incorporated.
into that larger volume of water. It may fall onto rocks, soil, grass, or pavement and travel downhill as runoff toward a stream, lake, or ocean. In most cases, water in streams eventually reaches a lake or the ocean.

If precipitation falls on permeable materials (e.g., sand or some soils), it may soak into or infiltrate into these materials. Infiltration moves water downward by gravity through rock or soil. It passes through a near-surface unsaturated or vadose zone and, at greater depth, eventually fills all the pores and cracks in the soil or rocks of the saturated zone. Water in the saturated zone is the groundwater portion of the water cycle. The water table marks the top of the saturated zone. Groundwater travels below ground and resurfaces at streams, lakes, wetlands, or oceans. If rocks or soil hold and transmit enough groundwater for human uses, they are called aquifers. Although many aquifers are analogous to sponges, with many small pores, some aquifers consist of rocks riddled with cracks, or rocks containing large caverns with actual underground rivers.

Remember the terms cycle and system, and notice how all the parts and processes in the water cycle are interconnected in a cohesive system. It is also important to remember that the water cycle is dynamic—water doesn’t just sit there, it moves! We have all observed surface water movement as runoff and streamflow, and have made the common sense observation that water flows downhill. Both the speed of movement and the balance between runoff and infiltration are influenced by a number of factors: steepness of slope, permeability of materials (e.g., loose grass-covered soil versus asphalt parking lots), intensity and length of rainstorms, etc.

Although it may be harder to visualize, groundwater is dynamic, too. Unlike a pool table, the water table is seldom flat; it consists of “hills” and “valleys” that mimic the overlying surface topography. In a rough sense, groundwater also moves “downhill.” Notice that the arrows indicating groundwater flow in figure 1 move downward away from hills. In general, the steeper these water table “hills,” the faster the groundwater moves. Groundwater moves much more slowly than surface water, with velocity also dependent on the aquifer material: approximately 50 feet per year in a “typical” aquifer, although water in cavernous aquifers may travel many feet per day. The water table itself does not stand still; it rises when more water infiltrates into the ground, and it drops during drought or if excessive amounts of water are pumped from wells.

Aquatic Systems

To really understand and protect the earth’s water, it is important to go beyond even the water cycle and examine aquatic systems. These systems consist of all water in an area (atmospheric, surface, and groundwater), as well as topography, soils, and rocks (surface and subsurface), biological components (plants, animals, and microbes), and all activities and impacts of a very powerful biological component: humans.

Aquatic systems have several important functions. Their numerous environmental functions include purifying water, recharging (replenishing) groundwater, collecting and retarding floodwaters, maintaining flow in rivers, and providing habitats for plants and animals. These systems also provide many domestic, agricultural, commercial, and recreational functions for human activities: transportation, dilution of industrial and domestic wastes, drinking water, laundry and cleaning, crop irrigation, cooling for power plants and factories, industrial uses, fishing, sailing, swimming, and many other activities.

Unfortunately, increased population and increasingly complex demands on aquatic systems have caused problems in many of these systems: pollution (by agricultural and urban runoff, sewage, chemicals, landfill leachate), decreased supply, sediment, flooding, aesthetic degradation, and loss of habitat and some plant and animal species.
Like water systems and cycles themselves, many of the problems are interrelated. For example, decreased water supply means not only less available water for drinking or industrial uses, but also less available water for diluting wastes, thus making pollutant concentrations even worse. Building a shopping mall with buildings and pavement in a former open field not only increases runoff and flooding potential but also covers areas that formerly allowed infiltration and recharge of groundwater. As a consequence of these multiple demands, physical, chemical, and biological components of many aquatic systems are altered.

How do we untangle this complicated web of problems? To work effectively toward solutions, we need to develop integrated programs of management, protection, and restoration of our aquatic resource systems.

Regulatory History

Historically, approaches to water problems have been fragmented or piecemeal. Unlike the actual interconnected cycle in nature, surface water and groundwater have often been addressed separately by regulatory agencies. (For example, a number of states strictly regulated water withdrawals from streams and rivers, but had no limitations on groundwater withdrawals.) Because it could not be seen, groundwater was virtually ignored in many earlier government regulations. Multiple agencies (state or several states, municipal, river authority, water utilities) might have jurisdiction within a single river basin. Water quality was frequently characterized by analyses of instream water samples and by investigation of obvious, discrete (point source) pollution sources located at the stream (e.g., a sewage treatment plant outfall or an opening from an abandoned mine). In many cases, communities of aquatic organisms were not thoroughly examined as indicators of the water’s “health,” and adjacent land use patterns were not studied. Nonpoint source pollution (diffuse input originating from large land areas or many small scattered sources) was seldom addressed as an important contribution to water contamination. Many nonpoint source pollutants (agricultural fertilizers, stormwater runoff) are strongly related to land uses. Although federal and state water regulations became gradually more stringent, they generally did not address water problems within an aquatic system framework. Data collection, needed to understand streams and aquifers and their problems, often received low priority and minimal funding.

More recent regulations and recommendations from federal and state governments have begun to recognize that a holistic or systems approach is necessary to solve water problems; several government research programs (e.g., in the U.S. Geological Survey and the U.S. Department of Agriculture) and a number of academic institutions have also acknowledged the importance of this approach. The Coastal Zone Management Act, Section 319 Nonpoint Programs of the Clean Water Act, total maximum daily loads (TMDL) legislation (see “TMDL Rule Finalized” on page 6), and the Clean Water Action Plan include elements of a comprehensive watershed framework. The 1986 amendments to the Safe Drinking Water Act (SDWA) established the federal wellhead protection program, and the 1996 SDWA amendments reauthorized funding for wellhead programs, underground injection control, and critical aquifer protection. It also mandated that states perform source water protection assessments and funded groundwater protection programs.

In addition, a number of states (e.g., Kentucky and Tennessee) have reorganized their agency programs to better integrate groundwater protection and watershed management in a manner more closely allied to the behavior of the natural water cycle and aquatic systems. Water Watch, Save Our Streams, Groundwater Guardian, and similar local and volunteer initiatives have proliferated.
Despite this progress, many governmental and academic programs still maintain divisions among the pieces of the water puzzle—between watershed and aquifer, source water protection and TMDLs, engineering and soil science, and geology and biology departments—and continued improvement in interagency and interdisciplinary cooperation are important to advances in protecting our water resources.

What Is a Watershed?

A watershed can be defined comprehensively as an area that contributes to recharging of surface and subsurface water bodies such as rivers, lakes, and aquifers. (See figure 2.) Any activities people conduct in this area will have direct effects on the quality of these waters. Farming, forestry, urban development, road construction, and use of onsite wastewater systems are just some of the activities that will have an environmental impact on the area and need to be considered as part of a watershed management scheme. To maintain adequate water quality, we must look at all activities that take place in a watershed and make sure that their environmental impacts are minimal. Watershed management is simply a systems approach to environmental protection.

To clean up a particular contaminant, we must recognize that it may come from multiple sources, identify which sources are significant contributors, and prioritize our efforts accordingly. For example, excess nitrate can originate from septic systems, sewage treatment plants, livestock manure, agricultural fertilizers, air pollutants in precipitation, or urban landscape maintenance, but land use patterns and population densities will dictate the proportion contributed by any of these sources within a particular area.

Because groundwater is part of the total water cycle, wellhead and aquifer protection follow similar concepts and approaches. Groundwater itself commonly discharges to the surface in valleys and topographic depressions. (See figures 1 and 3.) Springs that seep from cliff faces and roadcuts are one illustration of this phenomenon, and streams that flow perennially, even in times of low precipitation, are another example. If malfunctioning septic systems introduce contaminants into the groundwater, this contaminated water may eventually discharge to streams or other water bodies, polluting the surface water. For example, groundwater containing nutrients from subsurface wastewater disposal is a major source of high nitrate and phosphate concentrations in some New England coastal waters and several of the bays of eastern Long Island.

Role of Onsite Systems

So why does any of this matter to the wastewater professional who works with onsite and other small wastewater systems? Are onsite wastewater issues critical components of watershed protection? Absolutely! One survey of state water regulators lists septic tanks as the second greatest concern for potential adverse water quality impacts (Fetter, 1993). Some areas in the U.S. have identified onsite wastewater as an important issue within their watershed programs: Florida, New York City, Puget Sound, Cape Cod, southwestern Missouri, and parts of the Shenandoah Valley.

In agricultural and urban sewered areas, other contaminant sources may dominate, but in many other areas, lack of attention to the role of onsite systems—or at the other extreme, blaming onsite systems when multiple contaminant sources exist—may result from incomplete or in-progress watershed investigations. Professionals who work with onsite systems should become involved in watershed programs and lend expertise to identifying and correcting onsite problems, identifying areas where onsite systems provide adequate water quality protection, and assisting with educational efforts.

Figure 3

Groundwater Resurfacing. Septic tank effluent can move through groundwater flow to the stream.
A variety of specific wastewater issues may arise in a watershed or aquifer protection context. Without the participation of knowledgeable onsite professionals, there are dangers of either not correcting wastewater problems when necessary or spending large amounts of money on new wastewater systems when other sources may be the real problem.

In many states, public health departments have traditionally regulated onsite wastewater programs while water or environmental protection agencies have housed other point source and nonpoint programs. A systems approach to water quality requires closer cooperation and communication between these programs.

Although septic systems might intuitively appear to be point sources, in many rural areas, which constitute large portions of certain watersheds, inadequate onsite wastewater treatment from widely scattered households may actually constitute a form of nonpoint source pollution. Cumulative effects of numerous failing septic systems (due to improper siting, design, installation, or maintenance) or of numerous households lacking domestic treatment systems can be as serious as major point source inputs, such as substandard municipal treatment plants.

Concern with controlling nutrients (nitrate and phosphate) in both surface and groundwater may require evaluation of onsite systems in some areas. Although agriculture is a major source of excess nutrients in many watersheds, areas of suburban and rural residential growth may experience substantial nutrient inputs from domestic wastewater (e.g., Cape Cod, Long Island, and many lakefront areas). Even properly functioning conventional septic systems discharge nitrate and phosphate as end products, and...
it may be necessary to use both technological adaptations and wastewater management programs to reduce impacts from onsite systems in sensitive areas. However, in these areas, it is also important to evaluate and control impacts from other pollutant sources accompanying residential growth (e.g., lawn and garden fertilizers, pet waste, and concentrated populations of waterfowl).

Evolution of Onsite Programs

Measures necessary for watershed and groundwater protection have stimulated rethinking of some of our long-standing practices. Many environments, including some coastal, lakeshore, and floodplain areas, have perennially or seasonally high groundwater levels with water tables located near or at the ground surface. In these areas, onsite discharges intended for subsurface disposal may actually reach the surface or affect surface waters. (See figure 4.) In other cases, it is important to examine the effects of subsurface wastewater disposal on patterns of groundwater flow. Groundwater “mounding” caused by input of water from effluent discharge may locally impact groundwater flow, sometimes directing effluent toward environmentally sensitive areas. (See figure 5.)

Historically, most state and local onsite system regulations have focused on hydraulic disposal of effluent in subsurface soil to prevent public health risks from contact with sewage. Septic system failure has been defined as failure to reduce these risks; sewage appears on the ground surface or backs up into the house. Although subsurface hydraulic disposal keeps the sewage away from human contact, it does not necessarily ensure treatment, and it is also, unfortunately, often equated with an “out of sight, out of mind” attitude about septic systems.

More recently, some state and local onsite regulations have incorporated design and soil/site criteria intended to address wastewater treatment as well as disposal. Many state and local regulations now also mandate that onsite wastewater systems protect water quality as well as human health, and some of these regulations have also redefined system failure to include groundwater and/or surface water contamination. Expanding the role of onsite systems to protect water quality raises several interesting—and at times perplexing—questions.

How can we monitor water quality to determine whether onsite systems are a source of problems? We can see yard and street runoff to a lake, or cattle walking in and out of an unfenced stream, but because septic systems are buried, it is difficult to verify a connection, even if stream sampling indicates pollution. Groundwater monitoring may provide more definitive clues, but it is generally more costly and difficult than surface water monitoring, as well as more “hit or miss” because aquifers are hidden below the surface. And if multiple sources (e.g., septic systems, agriculture, and lawn care) affect a stream or an aquifer, it may be extremely difficult to determine the actual contributions from each source. In addition to careful collection of surface water, groundwater, site and land use data, watershed studies may require special techniques—chemical and physical tracers, isotopic studies, infrared and other geophysical detection methods, and DNA bacterial source typing—to identify and correct pollution sources.

What do we do about septic systems where the wastewater hydraulically disappears below the surface but moves through the soil too rapidly for sufficient treatment before reaching the water table, or where it rapidly reaches fractured bedrock and travels to groundwater or surface water without adequate treatment? Do we treat the wastewater to higher quality before releasing it into the soil? Slow down its movement within the soil to achieve better treatment? Treat it to high quality, disinfect it, and release it to surface water?

Although in some cases this last option may make sense for ease of water quality monitoring as well as treatment, in other instances it may be a difficult or even undesirable choice. Federal and state regulations governing discharges to streams...
may require strict and laborious permitting procedures, and some states entirely prohibit any discharge of onsite effluent to surface waters. Even in localities where surface discharge is an option, ongoing management of system operation and maintenance is imperative. If a surface-discharging system fails, it can become a public health threat, releasing untreated or partially treated sewage directly to surface water without an intervening “safety factor” of soil.

Arid regions of the U.S.—or humid regions where water supplies are stressed—may have an additional concern with wastewater in a watershed context: the use of wastewater to augment or replenish water supplies. Issues may involve greywater reuse, effluent use for irrigation, and effluent use for groundwater recharge. Wastewater/water supply interactions in arid-climate watersheds may also present some legal and regulatory questions, particularly where effluent provides a major source of water for wetlands or instream flows (e.g., Santa Ana River Basin in southern California).

**Technological Advancements**

Technological advancement has played an important role in small-scale and onsite wastewater management. We now have systems that, with proper operation and maintenance, can be used for onsite wastewater management in a variety of soil and site conditions that may be unsuitable for “conventional” septic systems.

Traditional attitudes in many areas have regarded onsite systems as less desirable, stopgap solutions to wastewater treatment until central sewers can be installed. Although this approach may make sense in areas of rapid, dense development—particularly those adjacent to sewered communities—the cost of extending sewers to each household in rural or sparsely populated areas may be impractical or impossible to absorb. Other factors—aesthetic, growth, and water supply—may make onsite or small cluster systems a preferable alternative to central sewers and treatment plants.

If conditions are not adequate for a conventional septic tank system and a sewer line is not available, there is a long list of alternative technologies available for treatment and disposal of wastewater on the site (refer to the list of informational products beginning on page 52). Sand filters, other media filters, aerobic treatment plants, and constructed wetlands are just some of the alternatives available for treating wastewater before discharge. Many newer technologies can produce secondary- or even tertiary-quality effluent.

Soil-based subsurface discharge requires adequate site conditions and sufficient area. The hydraulic capacity of the site will determine how much water can be discharged at a given site. Soil conductivity or infiltration rate (the ability of soil to move water from one place another) will determine the size of dispersal system you may need for a given amount of effluent. The rate of movement of wastewater effluent through the soil can also affect the soil’s ability to further treat the wastewater.

Alternatives available for subsurface discharge range from conventional soil absorption trenches or beds to highly effective drip systems. Shallow systems, low-pressure pipe systems, mound systems, and evapotranspiration/greenhouse systems are other alternatives that can improve distribution of wastewater in the soil and control the movement of wastewater to allow better treatment in the soil. Nondischarging systems (wetlands, evapotranspiration, and recycling) are in use in several areas of sensitive water quality, habitats, or site factors.

Although these treatment and soil absorption alternatives may cost more to build and operate than a conventional septic system, the cost may still be less than that of installing a centralized sewer system. Most importantly, using alternatives to treat and disperse wastewater onsite can often minimize adverse environmental impacts. However, two issues are paramount if a state or locality considers these alternatives: 1) because these systems generally involve more complex mechanical and/or electrical components, and because they may be used in more sensitive or “marginal” sites, it is essential to manage the systems from design through ongoing performance to provide public health and water quality protection; and 2) because the use of these systems can allow building on sites that cannot be developed otherwise, local and state officials may need to reconsider how decisions are made about land use planning and growth.

There is no doubt that we will see a continued emphasis on managing water quality by a watershed or systems approach in this new century. If we are to make the most of limited resources (natural, financial, and human), a systems approach is the only logical answer to the complex environmental issues we face. Water and wastewater professionals must play an increasingly important role in evaluating small scale and onsite wastewater treatment alternatives as viable options for watershed management.

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Dr. Jantrania, an agricultural and environmental engineer, formerly managed the NSFC technical programs.

**Reference**

State Regulators Gather in Colorado

Second Annual Onsite Wastewater State Regulators Conference
In June 2000, regulators from across the country gathered in Englewood, Colorado, for the second annual Onsite Wastewater State Regulators Conference. More than 50 state regulators from 34 states joined National Small Flows Clearinghouse (NSFC) staff and industry and government leaders for three days of intense discussions.

Topics ranged from voluntary management guidelines to technology verification and performance-based regulations. Conversations among attendees reached farther afield—to waste strength, lot size, soil depth, groundwater protection, and the difficulty of monitoring onsite systems.

“This is an information exchange,” NSFC Program Coordinator Peter Casey said in his opening remarks. “It’s your conference.” The agenda was created from results of a survey conducted after last year’s conference. Paul Chase, a consultant with Chase Environmental Services, Inc., in Rochelle, Illinois, said the survey indicated that issues generating high interest were onsite system management, technology transfer, performance-based regulation, funding, and general onsite wastewater regulations.

For many regulators, this gathering is the only opportunity during the year to meet with those holding similar positions in other states. State regulators often face the same challenges: onsite wastewater programs tend to be underfunded and understaffed. Many regulators walk a political tightrope and still grapple with the public perception that onsite systems are at the bottom of wastewater treatment options and that centralized community wastewater treatment—the “big pipe” approach—is always better. And it’s difficult to garner public support for a subject people don’t want to talk about.

“We don’t all have the resources, so we’ll have to beg, borrow, and steal from each other,” one regulator commented. “That’s why we’re here.” State regulators often face bureaucracies that either don’t have funds to verify new technology or are unwilling to pay for scientific studies, but expect regulators to establish laws and guidelines anyhow. “That’s what scares me,” said another regulator. “We’re setting rules by the seat of our pants.”

The NSFC established its onsite wastewater conference to give state regulators a forum in which to share information and gather insights that can help them develop rules in their own states. Priorities remain protecting public health and the environment.

The conference, which had the feel of a work group, was small enough to allow attendees from many different regions to contribute perspectives. The agenda consisted of a tight schedule of lectures, expert panels, breakout sessions, working lunches, and case study presentations. In fact, a few attendees commented that the schedule was too intense. Some wanted more time to network—or to slip out to nearby Denver for a Cirque du Soleil performance or to Coors Field for a Colorado Rockies game. And then there was the continual temptation to drive into the mountains and become immersed in the state’s awesome scenery.

Rules and Regulations

With the exception of California and Michigan, all states regulate onsite wastewater systems at the state-level. Mike Hoover, Ph.D, who spoke to the conference about performance-based regulation, described the onsite industry as a “moving target.” Two industry representatives at the conference explained the difficulty of attracting business people into an industry where regulatory oversight is often split between states, counties, cities, sanitary, and/or management districts. This can create a situation where, as one regulator commented, “Every Tom, Dick, and Harry decides onsite regulations.” However, when one attendee blurted out “maybe we need federal regulations,” an undercurrent of dissent rumbled through the room.

“Without regulations, industry shies away,” said Joe Walsh, president of Bord Na Mona U.S. from 1994 to 1999, during his technology transfer discussion. “It’s expensive to bring a product to market. If you go into a fragmented state that needs county-by-county approval, it’s very difficult. Some states are not commercially viable for new technologies due to existing siting concessions,” Walsh added. “Product approval is a long process.” And, he said, “Lobbying for legislative changes is common.”

With less funding available for centralized sewerage systems, increasing...
restrictions on effluent discharge quality, and states performing source water protection assessments to satisfy Safe Drinking Water Act requirements, onsite wastewater treatment and management are much more visible issues, and regulating onsite systems continues to rise in priority.

Andrew Lake, NSFC engineering scientist/geologist, opened the conference with information about NSFC’s State Regulations Database, which should be completed and accessible online by the end of the year. The database serves as a searchable repository of state onsite wastewater regulations. 

Onsite regulations tend to be a work in progress and compilations can be out of date the moment they’re published. Lake, who regularly updates the database, asked regulators to post to NSFC’s regulatory listserv when their respective states update onsite regulations.

Bill Evans, a regulator with New Hampshire’s Department of Environmental Services, suggested that since onsite regulations are so dynamic, NSFC might link directly to state regulatory Web sites. This option is now available through NSFC’s Web site at www.estd.wvu.edu/NSFC/NSFC_links.html. These links allow individuals to visit a specific state’s onsite wastewater regulatory authority Web site for regulations, regulatory contacts, and events underway within each state’s environmental agency.

Is a National Code the Answer?

Mike Corry, administrator of the Safety and Buildings Division for the Wisconsin Department of Commerce since 1989, presented a framework for a National Model Onsite Wastewater Code that he and Roman Kaminski, Wisconsin Onsite Program Manager, prepared. In Wisconsin, the Department of Commerce writes state building codes, including plumbing and onsite codes. Corry acknowledged Kaminski as their onsite expert. “Is the time right for a national code,” they asked?

Corry said onsite is the only segment of the constructed environment without their onsite expert. “The industry abounds with myths and lack of knowledge about treatment capabilities, and the country is rife with unreppaired failing systems. “Regulation makes the industry,” Corry said, “but it also inhibits growth.” Regulations, he said, may prove to be barriers to technological innovation.

How would we develop an onsite performance code? Corry said the answer is to begin with a performance matrix and guidance documents that suggest appropriate applications for local conditions. Basically, a performance matrix is a classification design where the Y-axis measures output performance via successively more stringent standards for wastewater effluent, from raw sewage to drinking water quality. And the X-axis represents successively more stringent descriptions of quality assurance levels, from a straight pipe with no intervention, to maximum level oversight, such as in utility-style management. One advantage of the matrix system, Corry said, is that “it is a technical evaluation system.”

A national code would need to decide which factors to measure (EPA has five steps on the X-axis; Mike Hoover has seven on the Y-axis), such as biochemical oxygen demand (BOD), nitrogen, total suspended solids (TSS), fecal coliform, E. coli, etc. Then, a measure of the variability of each needs to be determined—where, when, and how to measure—and they’d need to decide on a series of progressively more restrictive standards.

The main advantage of a national code to users is that it would provide a national consensus by peers and industry experts. The code can be adopted on a voluntary basis by local government or ignored at their option.

Corry also discussed possibilities for types of regulatory intervention, such as third-party management oversight—government, private, and utility. “People have failing systems, and they don’t care because there are no consequences,” Corry said. “If their water was shut off, they’d care.”

Previously, Corry served as chair of the Wisconsin Health Care Cost Commission, administrator in Wisconsin’s unemployment division, labor relations manager for Allen Bradley, Rockwell, sanitary for Milwaukee, U.S. Army Corps of Engineers company commander, and as labor relations manager for Milwaukee Metro Sewage District. He has a bachelor’s degree in geography and a master’s in business administration.

Onsite Management

Bob Rubin, Ph.D., is a North Carolina State University (NCSU) professor who has been involved with waste management issues for more than 25 years. Currently Dr. Rubin is working with EPA to develop a management program for onsite wastewater treatment systems.

“One of the programs we’re working on at EPA is management guidelines,” Rubin said. But before we get to management guidelines, he said, we need to talk about the quality of the effluent we’re treating: “What are the effluent standards? We’ve got to have standards for effluent, site evaluation, design, and installation.”

Bill Stuth, with Northwest Cascade-Stuth Wastewater Solutions, who has installed septic system for 45 years, commented, “All waste is not created equal. Waste consists of two characteristics: flow and waste strength, and little regard is paid to waste strength. Flow is determined by the number of bedrooms;” he
noted, adding that only a half dozen states mention waste strength in their regulations. “Performance-based standards must consider waste strength.” (For more about waste strength see Small Flows Quarterly, summer 2000, volume 1, number 2, page 14.)

Why manage onsite systems? To begin, part of groundwater recharge is through homes, etc., and thus is recycled wastewater effluent. “We need to protect wellheads,” Rubin said, “and onsite wastewater systems are used in areas where water supply is an onsite system as well. We must always be cognizant of surface water and groundwater interaction.

“How can we assure that we’re not having an adverse affect on surface water?” he asked, continuing, “Clearly there is a concern about what we do and how it impacts surface water quality. How big an impact is it? My guess,” he said, “is that it’s a pretty small impact compared to other insults to the environment.

“Onsite systems are cost-effective and clearly we’ve got to manage them more critically. We represent the largest wastewater treatment system in the country,” he said to the regulators, “and that is these land-based natural treatment systems. Clearly we treat more wastewater daily than the large municipalities do.”

Rubin said EPA publishes a number of items helpful to those working with onsite systems, including Clean Water State Revolving Fund (CWSRF) fact sheets, such as “Funding Decentralized Wastewater Systems Using the Clean Water State Revolving Fund” (EPA 832-F-99-001); technology fact sheets; and brochures. EPA is currently updating its Design Manual: Onsite Wastewater Treatment and Disposal Systems (NSFC Item #WW BKDM 35). The manual is completed except for the chapter about onsite system technologies. (The 1980 version is available from NSFC for $50. See page 63 to order.) Also, EPA is in the process of creating onsite management guidelines.

Rubin described an onsite wastewater management program as a series of elements and associated activities that allow public health and environmental protection for the life of a system. EPA suggests five management levels:

1. System inventory and awareness of maintenance needs;
2. Management through maintenance contracts;
3. Management through operating permits;
4. Utility operation and maintenance; and
5. Utility ownership and management.

(For further information, see “Update on EPA’s Draft Guidelines for Management of Onsite/Decentralized Wastewater Systems,” page 10.)

Rubin currently teaches environmental regulations and technology at NCSU, where his interests include onsite wastewater treatment spray irrigation and reuse, biosolids and septage management, and solid waste management.

Funding

Steve Hogye, who has worked with EPA for 12 years and serves as the NSFC project officer, addressed the conference about funding options for onsite wastewater systems. Funding is primarily available from three federal sources: EPA, U.S. Department of Agriculture (USDA), and the U.S. Department of Housing and Urban Development (HUD). EPA capitalizes state revolving funds and funds demonstration grants, such as the National Onsite Demonstration Programs; Environmental Technology Verification (ETV); and capacity development programs.

The EPA encourages states to open CWSRFs to the widest variety of water quality projects while still addressing highest priority projects. Hogye encouraged those interested in implementing or upgrading decentralized treatment systems to contact their state CWSRF agency, learn how the program works, and take part in the annual process that determines which projects are funded. Basically, he said to get your project on your state’s list. CWSRF programs in each state and Puerto Rico operate like banks. The EPA and each state fund the CWSRF, and use these assets to make low- or no-interest loans for important water quality projects. It is possible to arrange terms as long as 20 years to repay funds. The money is then recycled to finance other projects.

The EPA’s 1996 Clean Water Needs Survey Report to Congress, extrapolated from a database of approximately 16,000 publicly owned wastewater treatment facilities, estimates that $139.5 billion is needed to satisfy all program categories eligible for SRF funding for the “design year” 2016. Towns with populations of fewer than 10,000 need $13.8 billion, or 11 percent of the total documented need for the country. Smaller communities have a greater need for basic infrastructure than do large communities.

Projects that may be eligible for the CWSRF include:

1. Installing new systems to correct existing nonpoint source problems;
2. Replacing, upgrading or modifying inadequate or failing systems;
3. Costs, such as permitting or legal fees, associated with establishing a centralized management “entity,” such as a city, county, sanitary district, county service district, public or private utility, private corporation or nonprofit organization; and
4. Capital associated with centralized management programs.
Rubin commented, “If you’re going to use CWSRF funds for wastewater systems, it must be for septic systems that don’t discharge into surface water.” He added that if systems discharge to surface water, they must be managed.

The 1987 Amendments to the CWA authorized CWSRF to fund point source (Section 212), nonpoint source (Section 319), and estuary (Section 320) projects. Decentralized system projects that are solutions to nonpoint source problems may be eligible for funding under the latter two sections. Nationally, the CWSRF has more than $27 billion in assets. It has issued $26 billion in loans since 1998, and currently funds more than $1 billion in water quality projects each year.

USDA’s Rural Utilities Service offers water and waste disposal loans to “improve the quality of life and promote economic development.” At state levels, Rural Development field offices administer RUS loans, which include water and wastewater loans and grants through Water 2000—an initiative with a goal of providing clean, safe, and affordable drinking water to all rural homes by this year. The Clinton Administration started Water 2000 in 1994, and while the program has made impressive progress, anyone working in rural America knows there’s more work to do.

RUS offers water and waste disposal direct and guaranteed loans, water and waste disposal grants, technical assistance and training grants, solid waste grants, and rural water circuit rider technical assistance. In addition, Rural Development offices finance loans to help upgrade substandard low to moderate income housing through their Rural Housing Service. USDA also funds such organizations as the National Rural Water Association, which provides rural water and wastewater circuit riders; and the National Drinking Water Clearinghouse, which offers a toll-free hotline and more than 200 free products about small community drinking water systems.

HUD provides annual grants to 48 states and Puerto Rico to administer Community Development Block Grants (CDBG). Hawaii and New York elected to have HUD award their state grants rather than running a state program. CDBG grants may be used to rehabilitate residential and non-residential structures, construct public facilities, and improve water and wastewater facilities. (See list of funding Web sites on page 29 for more information.) Several states have set up infrastructure funds.

North Carolina, Pennsylvania, and Virginia have created state-funded programs that support decentralized systems. Ed Corriveau, an engineer with Pennsylvania’s Department of Environmental Protection who manages an Integrated Wastewater Planning, Management, and Financial Section, spoke about their state funding for onsite wastewater projects. Corriveau administers and oversees Pennsylvania’s municipally delegated onsite permit and enforcement program. He and his staff review both new onsite and conventional treatment systems using risk assessment planning techniques. He oversees repairs and compliance of existing problem areas and administers the technical reviews of the state SRF program.

Hogye added that in addition to federal funding, “Local communities have different sources, such as special appropriations, conventional loans, taxes, and fees from property assessments.”

Currently, Hogye is helping develop national onsite management guidelines. He has worked with several EPA programs, including water conservation, peer-matching U.S. water quality experts with those in Eastern Europe, and funding wastewater projects along the U.S./Mexico border. Previously Hogye worked on a variety of water quality and water supply programs for the Virginia State Water Control Board for 15 years.

**Technology Transfer**

Tom Stevens is manager of engineering and research services at National Sanitation Foundation (NSF) International and currently manages the joint EPA/NSF Environmental Technology Verification (ETV) Program’s Source Water Protection Pilot. The EPA created the ETV Program to verify the performance of innovative or improved environmental technologies and to get information out to the public.

ETV’s goal is to verify the environmental performance characteristics of commercially-ready technologies by evaluating objective, quality-assured data so that those who want to buy or permit the technology are assured of an independent credible assessment. The program provides high quality, peer-reviewed data on technology performance to those involved in design, distribution, permitting, purchasing, or using environmental technologies.

“Bottom line is you’re testing the vendor or manufacturer’s claims,” Stevens said, “and only what they claim.” Organizations that do testing must include reports of everything involved, including daily logs. ETV doesn’t certify technology with the NSF mark, nor does it issue a pass/fail. ETV distributes the technology report to the widest possible audience. If a vendor commits to ETV, “They can’t pull out,” Stevens said. “The results go forward.” Comments and electronic copies of ETV protocols are online at www/nsf.org/etv www.epa.gov/etv.

Walsh, who worked for Bord Na Mona U.S. when they introduced the
Puraflo Peat Biofilter to the U.S., said he feels manufacturers would agree to pay for third-party testing "if the end result is approval . . . or close to that." As it is now, a manufacturer often needs to put pilot studies in numerous states. "The biggest problem with new technologies is that they get a lot of attention at conferences, but not in the market place," Walsh added. "People want a conventional system if they can put one in."

Currently ETV funds 12 pilot activities—ETV subcontracts testing to a number of different sites—each operates somewhat differently from others. Testing is performed at controlled test sites. "Testing at individual houses is a nightmare," Stevens said. Public and not-for-profit private organizations serve as third-party verification partners, and Stevens said that stakeholder involvement is critical.

Stevens has worked in environmental engineering for more than 23 years. He has been involved with onsite wastewater treatment at NSF for the past 15 years and previously worked for several engineering consulting firms and the U.S Army Corps of Engineers. NSF and EPA both contributed funds to the regulators conference.

Other Technology Transfer Methods

Tom Groves, director of the Wastewater and Onsite Programs for the New England Interstate Water Pollution Control Commission (NEIWPCC) in Lowell, Massachusetts, presented a case study of a multistate technology transfer protocol in New England.

"The New England Interstate Water Pollution Control Commission has been conducting a project to evaluate innovative/alternative (I/A) onsite wastewater technologies—essentially a multi-state tech transfer program for the New England states and New York," Groves said. "This project deals with technologies that have been previously installed and tested in various locations throughout New England, New York, or the rest of the country."

The project’s purpose is to make the state approval and review process of proven I/A technologies easier. A description of the project and copies of the technology "Advisory Opinions" may be downloaded from NEIWPCC’s Web site at www.neiwpcc.org, under the heading "New Activities."

"The On-Site I/A Technology Evaluation Project that NEIWPCC is currently working on includes a Memorandum of Agreement (MOA) between all of the participating federal, regional, and state environmental and health agencies," Groves said. "This MOA describes the need for interstate cooperation, the importance of sharing data, etc. You may download a PDF version at www.neiwpcc.org/latech.html."

Groves has worked at NEIWPCC for 10 years and previously was employed at small engineering and land surveying firm. In addition to the onsite program, Groves also coordinates NEIWPCC’s Nonpoint Source Program. He recently was appointed vice president of the Yankee Onsite Wastewater Association. Groves has a bachelor’s degree in civil engineering from the University of Massachusetts at Lowell. Questions about NEIWPCC or their current projects may be directed to Groves at (978) 323-7929 or e-mail him at tgroves@neiwpcc.org.

Ted Loudon, president of the National Onsite Wastewater Recycling Association, (NOWRA) and a professor in Michigan State University’s Agricultural Engineering Department, gave a presentation about NOWRA’s place in the onsite industry. During his term as NOWRA president, Loudon presided over a Strategic Directions Committee evaluation of onsite needs. The process resulted in the NOWRA Model Framework for Unsewered Wastewater Infrastructure.

Loudon has been active in onsite research and Extension Service programs for more than 20 years. One of his activities has been research into sand filter performance in cold climates. For further information about NOWRA, call (800) 966-2942 or log onto the organization’s Web site at www.nowra.org.

What’s the Next Step?

Where do we go from here? In concluding the conference, NSFC’s Casey and EPA’s Jim Kriessl, who has worked in the wastewater field for 37 years, led a discussion about the conference’s future. The NSFC agreed to do the following:

- Produce a paper explaining what value we receive in coming together, which will be distributed to concerned individuals, responsible agencies, associations, etc.
- Look into options for a national organization. Chase listed three possible approaches for conference members:
  1. MOA [memorandum of understanding],
  2. affiliation, or
  3. stand-alone association
- Consider putting a state regulators column in Small Flows Quarterly.
- Put more news about state regulations in Small Flows Quarterly.
- Organize a third gathering.
- Evaluate the evaluation forms.

Chase has already completed a "Report on the Second Annual Onsite Wastewater State Regulators Conference."}

Harriet Emerson is publications supervisor for the Environmental Services and Training Division and former editor of On Tap, a National Drinking Water Clearinghouse publication about drinking water in small communities. She recently accepted a position as a national advisor for Environmental Compliance.

Useful Web Sites for Information about Funding Sources for Onsite Wastewater Treatment

U.S. Environmental Protection Agency (EPA) State Revolving Fund (SRF)
Program General Information: http://www.epa.gov/owm/finan.htm

EPA SRF Program State Revolving Fund State Contacts: http://www.epa.gov/owm/srfcon.htm

Funding Decentralized Wastewater Systems Using EPA’s Clean Water SRF: http://www.epa.gov/owm/septic3.htm


U.S Department of Housing and Urban Development (HUD) State Community Development Block Grant (CDBG) Program: http://www.hud.gov/cpd/cdbg.html

National Small Flows Clearinghouse: http://www.nsfc.wvu.edu
Elkton, population 180, is a small hamlet in southwestern Oregon, nestled on the banks of the Umpqua River. Life in Elkton, according to the city manager, is relatively simple and easy. And their choice of a recirculating sand filter to treat the city’s wastewater fits their lifestyle—the drainfield is a sheep meadow.

“It works perfectly for us,” said Linda Higgins, city manager for the past 17 years. “We are very happy with it. It’s pretty much maintenance free, works well with our public works schedule, and falls within our income guidelines. It fits us to a T.”

The recirculating sand filter system provides treatment for the entire community, including 16 businesses, two schools, three restaurants, a recreational vehicle (RV) park, several churches, and 66 residences.

Ten years ago, Elkton had a problem with failing septic systems polluting the groundwater and threatening the river. “There were just individual septic systems. Some people just had 55-gallon drums in the ground,” she said. “Things were really terrible.”

The problem of failing septic systems had been ongoing for many years. The city adopted new setback regulations in the early 1980s to combat the problems caused by failing septic systems. With the new setback requirements, however, came a new problem: no one could build on the lots because of space limitations. City officials realized that without adequate wastewater treatment, any future development was jeopardized.

The river is an important part of the community, so its protection also was a priority. Higgins said that the river is used mostly for recreational activities, such as fishing, boating, and swimming. In addition, the city now gets its water supply from it.

Although the water quality of the river was never tested, Higgins said contamination of the river was likely and a great concern to many at the time. “I am sure it was polluted at some point,” she said. “But I think the problem of not being able to build any new housing or replace what you have was the driving force behind us taking action.”

The Choice Was Easy

Higgins said the choice for the wastewater treatment system was relatively easy. “It was suggested by our engineer because of the size of the community and the fact that we have no trained personnel,” said Higgins.

Higgins said since Elkton is so small, it only employs one part-time maintenance worker for three hours per day. In those three hours, the worker is able to take care of the water system, the streets, the community building, and the sewer system.

Higgins said they did not have to persuade the public that a wastewater system was necessary. “Everyone was in favor of installing the system,” she said. “It was a needed thing for Elkton. And this system is pretty much maintenance-free.”

Another plus for the recirculating sand filter system was the significantly lower installation cost compared to other options. Orenco Systems Inc. of Sutherlin, Oregon, provided design assistance.
and equipment for Elkton’s system and continues to provide lab services.

How the System Works

Wastewater is pretreated and screened in individual septic tanks. One-third of these are septic tank effluent gravity (STEG) units with the remaining two-thirds using septic tank effluent pump (STEP) units to move effluent from the septic tanks to the central recirculating sand filter system.

From the septic tanks, effluent is transported by an effluent sewer collection system to the recirculating sand filter and drainfield for final treatment and dispersal. After passing through the filter media, recirculated effluent enters the flow-splitter, which returns 80 percent to the recirculation tank and sends 20 percent to the drainfield. A float switch in the recirculation tank signals the solenoid valve to close during low-flow periods, and 100 percent of the flow recirculates.

Final disposal of the treated wastewater takes place in 11,000 linear feet of trench, dosed by three, one-half-horsepower pumps. The disposal system is divided into 12 zones and is dosed sequentially.

Higgins said the 60 by 120-foot recirculating sand filter is designed to treat approximately 30,000 gallons per day. The wastewater entering the sand filter averages 141 milligrams per liter (mg/L) BOD (biochemical oxygen demand) and 32 mg/L TSS (total suspended solids). The treated sand filter effluent, which is dosed to the drainfield, has averages of 6 mg/L BOD and 6 mg/L TSS.

Show Me the Money

Total installation cost of the system was nearly $960,000, according to Higgins. Approximately 70 percent of the funding came from a grant from the Rural Economic Development Association (REDA), then known as the Farmer's Home Administration. The remaining 30 percent was funded through a loan from the REDA, which is being paid back through user fees, Higgins said.

According to the 1990 Census Report, more than 40 percent of Elkton’s residents are retired. Median household income in 1990 was $22,000, making low operating costs important, according to Higgins.

There is a $400 sewer connection fee, and residents pay $20 a month for the first 5,000 gallons of water and 60 cents per thousand gallons for additional usage. Usage is based on average use from October to March. Higgins said that allows people to feel free to water their lawns and gardens in the summer months. The school, RV park, and largest restaurant have the highest monthly bills, averaging $175 per month.

Oregon’s property tax system is primarily a rate-based system with a limit on assessed value. Higgins said Elkton’s property tax base is $15,000, which significantly limits their operating budget.

Operation and Maintenance

Higgins said the small amount of time allotted for the city worker has proved to be more than adequate to keep the wastewater treatment system running smoothly.

Terry Bounds, Orenco’s executive vice president and one of the system’s designers, agrees. “We have been monitoring the progress of Elkton’s system for 10 years. On average, there are fewer than four service calls per year, and some years there are none. “Most of the limited maintenance time is spent on the recirculating sand filter. It consists of daily readings of flow meters, elapsed time meters, counters, and monitoring of the seven pumps. It even includes weeding of the sand filter. And the system has been performing extremely well,” Bounds said. “The residential septic tanks were monitored for sludge and scum accumulation after six years, and to date, not one has required pumping.”

Hidden in Plain View

While location is everything in real estate, with this recirculating sand filter, location is not a big problem. “Our wastewater treatment system is not like many other towns’ systems,” Higgins said. “It’s located right behind the elementary school, next to the school’s playground field, and you would never know it. The sheep run on the drainfield.”

According to Bounds, the drainfield is “completely safe, both for the public and for the sheep, and is used to grow grass for grazing.” He added that the field is surrounded by a low sheep fence, and the sheep do no damage to the drainfield.

“The subsurface dispersal system was intentionally buried lower than it needed to be so that it would be below plowing level. The farmer plows the field, provides supplemental irrigation with river water, and keeps the field mowed,” Bounds said.

For additional information, contact Higgins at (541) 584-2547 or Bounds at (800) 348-9843, extension 218.
Editors Note: This is the first of a series of articles that will focus on alternative wastewater collection systems (sewers) for small communities.

Life in a vacation community isn’t always simple and carefree. Jim Gann, former president of the Beach Road, Texas, municipal utility district (MUD) can attest to this fact. In 1991, he and his neighbors began the difficult task of evaluating different wastewater collection and treatment systems to replace failing septic systems in their tiny resort town.

The community of Beach Road is located near Matagorda, Texas, on a delta that formed 70 years ago in the Colorado River near the Gulf of Mexico. The river’s flow was diverted and no longer floods in this area, making the delta permanently habitable.

However, the delta is located in an environmentally sensitive area and at an elevation of only one to four feet above sea level, which severely limits the community’s wastewater options.

After looking at different collection system technologies, including grinder pumps and pressure sewers, the MUD decided to further investigate the option of installing a vacuum sewer system to serve the vacation homes on the delta. At the time, there were no other vacuum systems in Texas.

Vacuum Sewer Technology Comes of Age

SFQ ASSOCIATE EDITOR

Cathleen Falvey
“Vacuum sewers looked great to us on paper, but we felt that they were an unknown, unproven technology,” said Gann. “We needed to find out more about how well the systems actually worked before making a decision.”

The MUD’s board members decided to research their vacuum system by requesting a complete client list from the manufacturer, developing a questionnaire, and sending it to every community on the list. The survey asked for basic information about the age and performance of the systems, and whether the communities would install vacuum sewers again if given the choice. The responses were overwhelmingly favorable.

“Almost every community that responded to the survey was happy with its vacuum system,” said Gann. “We also got great advice from the communities. For example, we knew it was important to take great care designing the system, selecting the contractor, and providing oversight during installation.”

Beach Road MUD installed their vacuum system in 1996. According to Gann, residents are “just happy that they don’t have any more sewage problems.”

Vacuum Technology Advances

Vacuum sewer technology has advanced considerably over the years and in the ten years since the Beach Road MUD first investigated their system. Although they were first patented in 1888 and have been used for commercial applications since 1959, vacuum sewers are still considered by many to be a new or experimental technology. But this view is rapidly changing.

Today, there are approximately 200 municipal vacuum systems operating in the U.S. alone, and there are many systems in Germany, France, Australia, and other countries around the world. The technology has improved as its application has expanded.

Early vacuum systems often had problems due to such factors as improperly planned vacuum main profiles, too-large liquid slug volumes, and the lack of full understanding of system hydraulics. These early problems forced the industry to pursue design and component improvements and develop operation and maintenance guidelines. System performance improved, and energy requirements for operation were reduced (Smith, 1999).

Vacuum sewers are gradually entering into the mainstream as more communities recognize them to be a reliable, environmentally safe, and cost-effective alternative to conventional gravity sewer systems.

Which Communities Should Consider a Vacuum System?

Traditionally, vacuum sewers have been viewed as a small community technology. They are practical for use in low-lying areas, such as in lakeside or coastal communities, or in areas with very flat or variable grade where the cost of constructing gravity sewers would be prohibitive. They also are a good option for areas with high groundwater, bedrock, or other subsurface difficulties. Any community considering centralized collection and treatment should investigate a vacuum system as an option.

Although the majority of vacuum systems are located in small communities, some large communities use them as well. A portion of Albuquerque, New Mexico’s, residents are on vacuum sewers. Other large systems include Sanford, Florida, with approximately 2,000 connections, and Ocean Shores, Washington, with 12,000 connections.

The city of Sanford chose vacuum sewers for a portion of the city to separate combined sewers that were overflowing into Lake Monroe. Factors that contributed to their decision to install vacuum sewers in this particular area were the condition of the streets, the small lot sizes, the large number of other utilities present in the alleyways, and lack of hydraulic gradient. The streets were made of brick, which would make a conventional construction project more expensive (CPH Engineers, 1990).

Because vacuum sewers employ narrow pipes buried in shallow trenches and do not depend on gravity to transport sewage, less extensive excavation is necessary for their installation. Engineers also can more easily adapt the configuration of the sewer lines to accommodate unforeseen obstacles and tight spaces.

In addition, vacuum systems are entirely enclosed systems. They have no manholes and operate under negative pressure. Both these factors greatly minimize inflow, infiltration, and exfiltration—problems common in conventional gravity sewers. For these reasons, vacuum sewers are often an option for environmentally sensitive areas.

How Vacuum Systems Work

Vacuum systems generally consist of three major components, the valve pit package (also called the service), the piping network, and the vacuum station. (Refer to the illustration on page 32.) Design and system components vary from manufacturer to manufacturer and occasionally are adapted for specific applications.

Because Airvac, Inc., has manufactured almost all of the vacuum systems currently operating in the U.S., for practical purposes, the following discussion about system components and operation is based on their proprietary design. In no way is this meant to be an endorsement of this particular system. (A list of the three companies that manufacture vacuum systems or have sales representatives working in the U.S. is provided on page 35.)

The Valve Pit Package

Typically, vacuum systems are designed so that sewage from individual homes flows through gravity lines to a buried, sealed collection sump, which is part of the valve pit package. Depending on the manufacturer, valve pits may serve one home or two or more homes.

Components of the valve pit design most commonly used in the U.S. include a sewage holding sump, a pit bottom, a valve pit that contains a three-inch vacuum interface valve, an in-sump breather unit, and a cast-iron manhole cover. (Refer to the illustration on...
The three-inch valve size is adequate for conveying diapers and the oversized items typically flushed down a toilet by mistake without clogging the system. (Some state standards suggest a minimum three-inch valve size.)

When 10 gallons of raw sewage accumulate in the sump, air trapped in the empty two-inch diameter sensor pipe pushes on a diaphragm in the valve's controller sensor unit to provide a signal to the valve to open. The vacuum interface valve automatically opens, and the sewage is sucked out of the sump.

Differential air pressure propels the sewage through the valve into the vacuum sewer network. The vacuum interface valve is pneumatically controlled and operated so no electricity is needed in the valve pit. The atmospheric air needed for sewage transport enters through a screened air intake on the homeowner's gravity line.

The Sewer Network
The vacuum sewer mains are four-inch, six-inch, or eight-inch polyvinyl chloride (PVC) pipes laid in shallow, narrow trenches. PVC pressure fittings are used for directional changes and for the crossover connections from the service lines to the main line. Lifts or vertical profile changes are used for uphill transport. A "saw-tooth" configuration typically is employed to provide lift to the flow, keep sewer lines shallow, and prevent the sewage from blocking pipes during low-flow periods. (The detail of a "lift" in the graphic on page 32 illustrates the saw-tooth profile.)

During low-flow periods, sewage lies at the lower areas of the pipes in the saw-tooth layout until more valves in the system open. As valves open and air enters the system, atmospheric pressure is admitted to the piping network, which is under negative pressure. The resulting pressure differential propels the sewage toward the vacuum station.

Sewage velocities of 15 to 18 feet per second in vacuum systems scour the piping and keep it free of obstruction. Because of this velocity and the saw-tooth configuration, flow in vacuum sewers can be uphill although there are limits to the amount of lift possible. The practical limit of uphill transport in vacuum systems historically has been 15 to 20 ft (4.5 to 6 m), although systems requiring higher lifts are being tested (EPA, 1991). Lift stations may be necessary for steep grades, adding to the cost of systems in these areas.

The Vacuum Station
The third component of a vacuum system is the vacuum station. One manufacturer prefabricates the vacuum station and ships it to the community on skids. The community must provide a facility to house the station. The vacuum station functions and has components similar to a lift station in a gravity system with the addition of the vacuum pump, which creates the negative pressure in the system.

Vacuum stations contain an enclosed collection tank, sewage pump, vacuum pump, and electrical controls. When the collection tank fills to a predetermined level, a sewage pump conveys the sewage from the station to treatment and disposal (Airvac, 1998).

Computer programs are available from manufacturers to help engineers design vacuum systems for specific applications. Manufacturer representatives also take an active part in project planning and design and overseeing construction and installation of the systems.

Operation and Maintenance
Vacuum systems have the somewhat undeserved reputation of having intensive operation and maintenance requirements. However, they do require a well-trained, part-time or full-time operator, depending on the size of the system. Therefore, operation and maintenance costs for a vacuum system may be higher than for some conventional gravity sewer systems. Reduced construction costs sometimes offset costs for system operation and maintenance.

One advantage of vacuum systems is that malfunctions usually are noticed and addressed rather quickly by the operator. This is in contrast to conventional sewer systems in which major inflow and infil-
Vacuum system manufacturers offer extensive operator training and provide equipment manuals. Some communities may have the option of contracting with local manufacturer representatives for system operation and maintenance.

Operators must know how to troubleshoot systems. On a daily basis, they should visually check the gauges and charts, record pump run times, and check the oil and vacuum station controls. They must regularly perform preventive maintenance on the systems, such as inspecting and testing division valves, vacuum valves, and alarms, and inspecting vacuum and sewage pumps for wear.

Vacuum valve malfunctions do sometimes occur. If a valve fails in the open position (the most common occurrence), problems will be evident by reduced vacuum conditions in the system. Operators learn how to locate the valve by observing and isolating different parts of the system. Manufacturers provide information for valve troubleshooting and servicing, and some valves can be manually cycled and tested by the operator. Some valves are designed to be partially unscrewed if an object were to become lodged in them.

Valves that fail in the closed position can cause system backups and usually are immediately detected when homeowners call for service.

Vacuum System Advantages and Disadvantages

Some advantages of vacuum sewers for communities include the following:

- vacuum sewers reduce treatment costs by reducing or eliminating inflow and infiltration;
- no manholes are necessary;
- field changes in system configuration can be made easily as unforeseen underground obstacles are encountered;
- shallow installation reduces project costs and environmental impact;
- high sewage transport velocities reduce the risk of blockages and keep wastewater aerated and mixed;
- the enclosed system eliminates odors, protects the environment, and minimizes health risks to operators;
- major leaks are detected and addressed immediately, which protects the environment and the community’s infrastructure investment;
- only one source of power (at the vacuum station) is typically necessary; and
- exfiltration is eliminated.

Potential disadvantages of vacuum systems include the following:

- the amount of lift possible is limited in steeply graded areas;
- are generally not cost-effective for fewer than 50 connections;
- may have difficulty accepting very large flows of 120 gallons per minute or more at a single connection;
- a site and facility is required to house the vacuum station; and
- a full- or part-time operator is required (Smith, 1999).

Vacuum System Manufacturers

The following three companies manufacture systems or have sales representatives working in the U.S.

Airvac, Inc.
4217 North Old U.S. 31
P.O. Box 528
Rochester, Indiana 46975
Phone: (219) 223-3980
www.airvac.com

Iseki Utilities Services, Inc.
Avonbrook House
Masons Road
Stratford-upon-Avon
WAR CV37 9LQ
England
Phone: 44 1789 292436
www.iseki-vacuum.com

Roediger Pittsburgh, Inc.
3812 Rte. 8
Allison Park, Pennsylvania 15101
Phone: (412) 487-6010
www.roediger.com

Costs

Capital costs for vacuum systems vary depending on site conditions and manufacturers’ prices. The installed cost of vacuum sewer mains is very site specific but may be as much as 60 percent lower than gravity mains and 10 percent higher than pressure sewer mains. Valve pits range from $2,500 to $3,500 installed. Two homes typically share one valve pit, making the cost per home $1,250 to $1,750.

The cost of vacuum stations range from $200,000 to $450,000 and serve from 50 to 1,500 homes. Larger stations benefit from economies of scale and may cost as little as $300 per home. The smallest vacuum stations may cost up to $4,000 per home.

Overall, vacuum systems range from $2,500 to $7,500 per connection (Smith, 1999).

The low costs for equipment and installation are advantages of vacuum sewer systems. However, communities must consider whether these initial savings in capital costs are offset by operation and maintenance costs over the life of the system. A detailed discussion of vacuum system life-cycle costs and strategies for estimating costs are offered in the EPA manual Alternative Wastewater Collection Systems (EPA, 1991).

For More Information

In addition, the National Small Flows Clearinghouse (NSFC) offers several documents on vacuum sewers, including the items mentioned in the references listed below and in the list of NSFC products beginning on page 57. When requesting materials from the NSFC, please be sure to refer to them by both title and product number.

Communities also should contact vacuum system manufacturers directly to request more information about their systems and to obtain a complete list of communities using these systems.

References


Practical Pointers
for Onsite System Inspectors

CONTRIBUTING WRITER
Patricia Miller, Ph.D.

Across the U.S., inspection of existing septic systems is becoming increasingly more common and more important in onsite wastewater management programs. If you are an onsite system inspector, you face certain legal, regulatory, and procedural concerns in addition to the many technical issues involved in the practice of evaluating onsite systems. Although these concerns will vary from place to place depending on local codes and practices, I have attempted to list the important ones here.

Onsite system inspectors need to be aware of legal issues in advance to avoid lawsuits, penalties, or loss of certification, and to maintain good relationships with the client and the code officer. To this end, this column includes some questions you should ask your local code officer and your lawyer.

Follow Contracts Carefully
A major source of legal disputes in some states involves completion of work stated in the contract for an inspection. If you state in a contract that you will perform certain inspection procedures (e.g., pump and inspect the inside of a septic tank), make sure that you do so. Do not make statements or record information about any parts of a site or system that you have not actually observed.

Before preparing any contracts, consult with your lawyer about appropriate procedures for sites where part or all of a system is inaccessible for inspection (e.g., vicious dog in the yard or patio built over septic tank access).

Check Local Codes! Check Local Codes!
You cannot overstate the importance of checking local onsite system codes. Questions you should ask your local code officer include the following:

- Who is authorized to conduct inspections? (Engineers? Sanitarians? Private inspectors?)
- Are there any restrictions on who performs certain procedures or levels of inspections? (Load tests or soils evaluation may require certain designated experts. Your codes may require that sand filters, aerobic treatment units, or other advanced treatment systems be inspected only by an engineer, or that a certified inspector complete additional specialized training before inspecting these systems.)
- What are the certification requirements? Are there specific local requirements? Are there state or national programs (e.g., National Association of Waste Transporter [NAWT] or NSF International) that your locality accepts? Are training courses, exams, and/or spot field checks by a code officer required? Must you meet certain required standards for insurance coverage to obtain certification? Are there requirements for continuing education or recertification?

Check Requirements for Long-Vacant Homes
Local codes may require or recommend specific procedures for inspecting systems at residences that have been vacant for a long time. For example, do they require or suggest follow-up inspections after the house becomes occupied? There are several points for inspectors to note here:

There are some indicators of system problems that may be observed even after a long period of vacancy; some programs also recommend/require hydraulic load tests to approximate normal system function. However, none of these procedures can truly substitute for observing a system under normal operating conditions. For a house that has been vacant for a long time, you may be unable to make many observations that are part of your normal inspection routine.

Regardless of local code requirements, it is important to note in your reports that the house has been vacant (note how long, if possible). Be clear that you are recording conditions at the time of inspection and record only those items that you are actually able to observe. If you use a checklist in performing your inspection, it is a good idea to note “not observed” for any item
you were unable to observe.

Check with your code office and your lawyer beforehand about what to do if, during an inspection of a long-vacant house, you observe so little that you feel uncomfortable making an evaluation.

Know Your Role as Inspector

What do your local codes say about the inspector’s responsibility for observations, judgments, and recommendations? Find out if your codes specifically require or prohibit the following from the inspector:

- observations of obvious problems,
- warnings of potential problems,
- recommendations for further evaluation,
- recommendations for preventive maintenance, and
- cautions regarding changes from current wastewater loadings or household habits.

In addition, it is important for inspectors to know whose role it is to state whether a septic system is acceptable/conditional/unacceptable, or satisfactory/unsatisfactory. Is the inspector expected to identify a “failed” system, and, if so, how does the local code define “failure”? Even if you cannot pronounce a system “failed,” are you expected to report certain signs of failure or factors leading to failure? What is your role and responsibility in recommending corrective measures?

These issues vary widely among local codes, and it is important to clarify your legal role and responsibilities. For instance, in some localities, the inspector is expected to make observations about the condition of the system, judge whether the system is satisfactory or unsatisfactory, and recommend corrective measures if needed. In other jurisdictions, the inspector is required to make detailed observations about the system, but the local environmental health officer determines “pass-fail” and necessary corrections.

What If Systems Require Repair?

Special questions apply to systems needing repair. Are repair permits required, and, if so, are they required for any repairs or only for specific major repairs? For many minor repairs (e.g., replacing a broken tee), you may feel that you can save the homeowner time and money by doing the repair at the time of inspection. However, you should determine beforehand if such repairs are considered a conflict of interest, or if your locality has a list of minor repairs considered acceptable at the time of inspection. If minor repairs are allowed, determine if you need any special permission (such as a phone call to the local health department) and if you must follow specific reporting procedures about the repair.

You should know how your locality addresses systems that are in acceptable condition but do not meet current codes. Do you make this judgment or does a local health official? Can the system be left as is? If so, must you provide cautions about a “noncompliant” system? Or must the system be upgraded to current code? How do you inspect and report on cesspools, drywells, privies, or other systems that may be completely outlawed by modern codes?

Know Your Liabilities and Protect Yourself

Inspectors should be aware how liability is divided among the parties involved in an inspection (i.e., the inspector, regulatory agency, seller, buyer, etc.). What are your particular liabilities? Is liability insurance required or recommended?

In addition, it is wise to develop a quality assurance/quality control protocol for your inspection business. This documented procedure can be invaluable in the event of audits or legal proceedings.

Local requirements for reporting will vary. You should know if you are required to submit a checklist, a written report, or both. Are there specific forms that you must use and/or certain information that you must include? Who should receive copies of the report? If you must report inspection results to a local agency, what are the required time frames and deadlines?

There are several other documents that may clearly define your responsibilities to the client and may be useful in the event of a legal dispute. If the documents are required by local code, your code officer may have certain forms that you must use or information that must be included in your own forms. If they are not required by local code, you may want to consult your lawyer or professional organization regarding format and use of these documents:

- Terms and Conditions and Scope of Services commonly specifies terms, conditions, procedures used, and limitations of the inspection. If you are conducting the inspection as part of a regulatory requirement, reference the appropriate ordinance or code.
- An Inspection Authorization Form acknowledges that you are on the property, conducting the procedures needed to complete an inspection (including any required excavations), for certain agreed costs. It should include access to the interior of the house as needed for inspection procedures. It may also include permission to disclose any records of past history and permission to contact any previous pumpers or inspectors.
- Disclaimers clarify that observations made are based on the condition of the system on the day of inspection and that no warranties are implied concerning future functioning of the system. They also may state that no evaluation will be attempted for parts of the system inaccessible at the time of inspection.

Because cultural, political, and financial factors vary among states, counties, towns, and watersheds, inspection programs may be tailored to meet local concerns. While this variation may seem frustrating and illogical to some in the technical community, it is important to remember that local acceptance of these programs is a critical step toward onsite system management.

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A Survey of Home Aerobic Treatment Systems Operating in Six West Virginia Counties

ABSTRACT: This article summarizes the findings of a 1998 survey of ATU systems (home aerobic treatment unit plus chlorination) in West Virginia. ATU systems in six counties were evaluated to determine whether the units were meeting health and environmental regulations. Of the 419 ATUs examined, 85 were sampled for additional laboratory analyses, which included biochemical oxygen demand (BOD), total suspended solids (TSS), and fecal coliforms (FC). Approximately 150 units were tested for chlorine residual and turbidity. Data from the study will be used to guide state policy with regard to the monitoring of ATUs on existing sites and the permitting of ATUs for use in new construction sites.

Since 1983, home aerobic treatment units (ATUs) have been installed in many counties in West Virginia to correct existing septic system failures. These units are designed to aerobically treat domestic wastewater flows of 600 gallons per day (gpd) or less and employ chlorination as a final disinfection step. More than 4,000 ATUs that discharge into rivers, streams, and other surface water drainage areas have been installed in West Virginia. Approximately 800 new ATU installation permits are issued in the state each year.

Currently, the West Virginia Bureau of Public Health requires that every ATU “system” (treatment unit plus chlorination) meet the National Sanitation Foundation Standard 40 Class I standards (monthly average of 30 mg/L five-day biochemical oxygen demand [BOD5] and 30 mg/day for total suspended solids [TSS]) (NSF, 1990) and the West Virginia state standard for chlorine disinfection (maintenance of 0.5 mg/L residual in the discharge) (WVDNR, 1991). However, it should be noted that tablet chlorinators are add-on devices on most ATUs and are not included in the NSF Class I Standard.

Included in the NSF standard is a requirement for a two-year operation and maintenance contract from the ATU distributor. After two years, the homeowner is responsible for ensuring maintenance is performed on the system. Despite this requirement, routine maintenance beyond the mandated two-year period may not always be performed.

This article summarizes the findings of a 1998 survey of ATUs in West Virginia. ATU systems in six counties were evaluated to determine whether the units were meeting health and environmental regulations. Most units were originally installed to replace failed systems. The type of unit installed varied by county according to the availability of distributors in that area.

OBJECTIVES

Of the 419 ATUs examined, 85 were sampled for additional laboratory analyses, which included BOD, TSS, and fecal coliforms (FC). Approximately 150 units were tested for chlorine residual and turbidity. The survey was performed by the Environmental Services and Training Division and the Environmental Microbiology Laboratory, both at West Virginia University (WVU), and six county health departments, and with assistance from the West Virginia Bureau of Public Health.

The project objectives were to survey existing ATUs for proper operation and maintenance and to determine the chemical and microbiological quality of their effluents. The following questions were considered:

• Are the West Virginia state requirements for disinfection of ATU effluents being met?
After the two-year maintenance contract expires, are West Virginia ATU systems meeting state division of environmental protection discharge requirements?

- Should mandatory maintenance of ATUs be required beyond two years in West Virginia?
- How satisfied are homeowners with their ATUs?
- Could turbidity be used as an indicator of ATU failure?

Data from the study will be used to guide state policy with regard to the monitoring of ATUs on existing sites and the permitting of ATUs for use in new construction sites.

MATERIALS AND METHODS

ATU Selection

A full list of permits for ATUs in the West Virginia counties of Cabell, Kanawha, Lincoln, Jackson, Marion, and Monongalia was compiled. One hundred permits from each county were selected at random by the West Virginia Bureau of Public Health. All records were checked for completeness. Recently permitted units (i.e., those permitted less than one year before the survey) were excluded. Each set of 100 files was distributed to the appropriate county sanitarians who selected ATUs for inspection.

Field Inspections

Field inspections were performed on a total of 419 units by a National Onsite Demonstration Program (NODP) staff person in conjunction with a county sanitarian. The field inspection procedure began with an interview of the homeowner when possible. Homeowners were asked about their system, if it had malfunctioned, if they were pleased with it, and if it was still under service contract. Each ATU was inspected to determine if it was running, if pumping was needed, if operational problems were observed, and if the chlorinator was functional. Problems were noted on an inspection report. Typically, 12 to 15 systems were inspected per day.

Of the inspected ATUs, field measurements of residual chlorine and turbidity were performed on effluent from approximately 150 units. Effluent from 85 of these units was obtained for laboratory analyses (approximately 15 per county). In the absence of a detectable ATU discharge, the homeowner was asked to flush a toilet several times and run water through a tap prior to sample collection.

Following the collection and disposal of approximately 750 mL, triplicate samples (750 mL each) of ATU effluent water were aseptically collected in sterile one-liter Nalgene bottles containing three mL of 10 percent sodium thiosulfate. Samples were packed on ice in insulated coolers for immediate transportation to the WVU laboratory, then refrigerated. They were processed within 24 hours of their collection in the field and were equilibrated at room temperature for approximately 30 minutes prior to testing.

Total Suspended Solids (TSS)

TSS were determined according to state standard procedures (WV DNR, 1991). A dried glass filter disk (Gelman glass fiber disk) was weighed and used to filter a 50-mL sample. Following rinsing, the filter was dried overnight at 120°C and reweighed. Total suspended solids were calculated by difference in filter weights.

Fecal Coliforms (FC)

FC were enumerated according to Standard Methods (American Public Health Association, 1995). Samples were suspended in 0.1 percent peptone buffer, and passed through a 0.45 μm filter (Millipore). Samples were plated on Bacto mFC agar (Difco) and incubated in a water bath at 44.5°C for 24 hours. FC were enumerated as dark blue colonies forming on these plates. Plates with 20 to 60 but no more than 200 colony-forming units (CFUs) were countable. Phenol red mannitol broth was used to confirm that selected colonies were coliforms; those producing gas in this medium were considered positive.

Five-Day Biochemical Oxygen Demand (BOD5)

BOD5 was determined as described in Standard Methods (American Public Health Association, 1995). Samples (1, 5, or 10 mL) were added to standard BOD bottles (300 mL), which were then filled with aerated phosphate buffer solution, and incubated in an incubator at 25°C. Initial and five-day dissolved oxygen readings were determined using a Clark-style oxygen electrode (O rion model 97-08-00). BOD5 was calculated using the following equation:

\[
\text{BOD}_5 = \frac{\text{initial DO} - \text{final DO}}{(\text{mL sample/total mL})} 
\]

where: DO = dissolved oxygen

A mathematical correction to remove the contribution of chemical oxygen consumption by thiosulfate contained in the original sample collection bottles was employed.

Turbidity and Residual Chlorine

Turbidity was measured in the field using a Hach Pocket Turbidimeter, which allowed turbidity measurements ranging between 0 to 400 Nephelometric turbidity units (NTU). ATU effluent (5 mL) was collected in the sample cell, and a stable turbidity reading obtained. Cross-contamination between samples was avoided by cleaning the sample cell with Liqui-Nox detergent, sterile cotton swabs and distilled deionized water. Accuracy of the Hach Pocket Turbidimeter is ±5 percent or ±0.1 NTU (whichever is greater) when calibrated using StablCal Standards. The resolution is 0.1 NTU below 100 NTU and 1 NTU from 100 to 400 NTU.

Residual chlorine in 25 mL of ATU effluent was determined colorimetrically (Hach model CN-80) using a Hach free and total chlorine kit. Between samples, glassware was cleaned as described above.

Survey

The 85 samples analyzed above were part of a larger study in which 419 ATU systems were examined in six counties. Inspectors attempted to complete a questionnaire for each of the 419 systems [1]. Homeowners, if present at the time of the visit, were given the opportunity to express their opinions and satisfaction or dissatisfaction with their ATU by answering a series of questions. These questions included rating the system, based on the homeowners satisfaction with the system, between 1 and 5 (1 being unsatisfied and 5 being very satisfied). Other questions determined how often the system had malfunctioned, how many times the system had been pumped, and explanations of malfunctions and dissatisfactions.

Data Analysis

All water samples were analyzed individually and the three replicate values were used to calculate means reported in the tables and figures. All statistical and regression analyses were performed using Microsoft Excel 97 and JMP 3.1.5 (SAS Institute Inc.).
RESULTS

The West Virginia Division of Environmental Protection’s (W V DEP) Office of Water Resources (OWR) has proposed a new general permit for domestic sewage disposal systems that have design flows of 600 gpd or less and serve individual residences. This permit targets the installation of new ATUs and requires a concurrent maintenance contract for a period of five years. Owners of previously installed ATUs were required to carry a service contract for only two years and will be required to have perpetual maintenance in the future due to new guidelines adopted by the West Virginia Bureau of Public Health. The proposed discharge limitations of the new permit are summarized in table 1.

Because grab samples were used in the present study, ATU’s whose effluent values exceeded 75 mg/L BOD₅, 75 mg/L TSS, and 500 FC/100mL were determined to be noncompliant. These “failure” limits are more generous than the NSF Standard 40 Class I standard (i.e., 60 mg/L BOD₅ and 100 mg/L TSS as maxima for individual grab samples). In addition, the NSF Class I standard requires no maximum value for FC.

**Laboratory Analyses**

Mean values were determined from three consecutive effluent samples from 85 ATUs for TSS, BOD₅, and FC as well as for turbidity and residual chlorine. Mean values were compared to limits established for individual grab samples (table 1). The percent exceeding the proposed limits are presented in table 2a with 92 percent exceeding the limit for grab samples in at least one parameter.

The percentage of sampled ATUs exceeding the proposed limits for TSS, FC, and BO D₅ are summarized in table 2a. Histograms representing the distribution of sample values for these measurements are summarized in figures 1 to 3. Table 2a shows that of the measured parameters, ATU’s best met the guidelines for TSS. Only 27 percent of the samples measured exceeded the individual grab sample limit of 75 mg/L for TSS. Some of the higher TSS measurements were associated with unusual problems, such as the presence of insect larvae in the effluent.

ATUs were much less successful when evaluated by their ability to meet the limits established for FC and BO D₅. Grab sample limits were exceeded by 89 percent and 40 percent of ATU’s for FC and BO D₅ measurements, respectively. Twenty-four percent of the BO D₅ values measured were similar in magnitude to those obtained from primary clarified effluent (Hench, 1997) and septic tank effluent values reported in EPA, 1980. Lack of sufficient primary settling, inadequate aeration of the activated sludge, and inadequate flocculation of microbial biomass after secondary treatment all could contribute to high BO D₅ values.

Currently, ATUs in West Virginia are required to be under a maintenance contract for the first two years (as per NSF Standard 40 Class I requirements). Despite the fact that they are maintained under ATU distributor contracts, table 2b indicates that only two of the 12 units sampled with age ≤ 2 years meet the proposed WV DEP guidelines.

Data indicating high numbers of FC bacteria are probably best explained by inadequate disinfection (chlorination) of the effluent stream. Data in table 3 show that most samples (62 of 85) had no appreciable residual chlorine in the effluent and inspection of the ATUs indicate that problems existed with the tablet chlorinators installed on many units. Of the 84 units field tested for chlorine residual, 74 percent of the units had no measurable chlorine residual. The remaining units had chlorine residual values ranging from 0.1 to 0.9 parts per million (ppm). Only three of the units had a measurable

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**Table 1**

Proposed WV DEP/OWR Standard Discharge Limitations for ATUs

<table>
<thead>
<tr>
<th></th>
<th>Average Monthly</th>
<th>Maximum Daily</th>
<th>Maximum Individual Grab Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>30 mg/L</td>
<td>60 mg/L</td>
<td>75 mg/L</td>
</tr>
<tr>
<td>FC</td>
<td>200 per 100mL</td>
<td>400 per 100mL</td>
<td>500 per 100mL</td>
</tr>
<tr>
<td>BOD₅</td>
<td>30 mg/L</td>
<td>60 mg/L</td>
<td>75 mg/L</td>
</tr>
</tbody>
</table>

**Table 2a**

Percentage of Measured Samples Exceeding Proposed WV DEP/OWR Limitations (n=85)*

<table>
<thead>
<tr>
<th></th>
<th>Average Monthly</th>
<th>Maximum Daily</th>
<th>Maximum Individual Grab Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>48%</td>
<td>29%</td>
<td>27%</td>
</tr>
<tr>
<td>FC</td>
<td>93%</td>
<td>92%</td>
<td>89%</td>
</tr>
<tr>
<td>BOD₅</td>
<td>69%</td>
<td>46%</td>
<td>40%</td>
</tr>
<tr>
<td>Percentage exceeding one or more limitations</td>
<td>95%</td>
<td>94%</td>
<td>92%</td>
</tr>
</tbody>
</table>

*see table 1

**Table 2b**

Percentage of Measured Samples (age < 2 years) Exceeding Proposed WV DEP/OWR Limitations (n=12)*

<table>
<thead>
<tr>
<th></th>
<th>Average Monthly</th>
<th>Maximum Daily</th>
<th>Maximum Individual Grab Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>25%</td>
<td>17%</td>
<td>8%</td>
</tr>
<tr>
<td>FC</td>
<td>83%</td>
<td>83%</td>
<td>83%</td>
</tr>
<tr>
<td>BOD₅</td>
<td>75%</td>
<td>58%</td>
<td>50%</td>
</tr>
<tr>
<td>Percentage exceeding one or more limitations</td>
<td>83%</td>
<td>83%</td>
<td>83%</td>
</tr>
</tbody>
</table>

*see table 1
chlorine residual that met the state’s 0.5 ppm standard. High BOD₅ in some units also could contribute to the low residual chlorine observed.

Turbidity was tested in the field on 84 of the 85 units sampled for laboratory analysis (table 4). Thirty-three percent had turbidity less than 25.0 NTU. Fifty-two percent of the units had a turbidity value less than 50.0 NTU. Fourteen percent of the units tested had a value greater than 200.0 NTU.

Attempts were made to determine whether this relatively simple measurement was predictive of other more difficult measures such as TSS, FC, and BOD₅ (figures 4, 5, 6). The coefficients of determination (R²) demonstrate that only the natural logarithm (ln) of TSS showed a reasonable linear relationship to turbidity, and the sensitivity of that relationship is not sufficient to use for monitoring ATU effectiveness. Regression analysis also revealed no relationship between FC and BOD₅ (figure 7). Similarly, age of the ATU’s was not predictive of any measured parameter (figures 8, 9, 10, 11).

**Field Analyses**

The 85 samples analyzed above were part of a larger survey in which 419 ATUs were field inspected in six counties. Inspectors measured residual chlorine and effluent turbidity and attempted to complete a questionnaire for each unit. Completeness of the information obtained varied according to the availability of the homeowner, accuracy of their records and/or recollections, accessibility of the ATU unit, and thoroughness of the inspector. Although the completeness of the information obtained was variable, some useful generalizations are suggested by the survey.

Chlorine residual was tested in the field on 149 units (table 5). Sixty-eight percent of the units had no chlorine residual. The remaining units (32 percent) had chlorine residuals; however,
Figure 4
Turbidity vs. Natural Logarithm (ln) TSS

Figure 5
Turbidity vs. Natural Logarithm (ln) BOD₅

Figure 6
Turbidity vs. Log₁₀ Fecal Coliforms (FC) per 100 mL

Figure 7
Log₁₀ Fecal Coliforms (FC) vs. Natural Logarithm (ln) BOD₅

Figure 8
Age vs. Natural Logarithm (ln) Turbidity

Figure 9
Age vs. Natural Logarithm (ln) Total Suspended Solids (TSS)

Figure 10
Age vs. Natural Logarithm (ln) BOD₅

Figure 11
Age vs. Log₁₀ Fecal Coliforms (FC)
only seven units had a value that met the state’s 0.5 ppm standard.

Turbidity was tested in the field on 148 units (table 6). Thirty-seven percent had a turbidity value under 25 NTU. Over 61 percent of the units had a turbidity value under 50 NTU.

### Relationships Between Maintenance/Chlorination Deficiencies and Grab Sample Standards

All 419 ATUs were inspected for a variety of total deficiencies, including ATU maintenance deficiencies and chlorination deficiencies. Inspectors examined for the following maintenance deficiencies:

- grounds (surface drainage, weeds, debris, access);
- unit controls (presence of a timer, warning device, overload protection, suitable wiring, access);
- waste stream pretreatment (type, size, condition);
- aeration compartment (aerator, blower/air line, roll; splash bowl, septic solids, odor, wiring/power);
- settling compartment (skimmer, tube settlers, outlet tee, floating solids, outlet weir, excessive scum);
- additional treatment (type, sand filter, polishing pond, modified wetlands); and
- effluent (clarity, odor, color).

Inspectors also examined ATUs for the following chlorination deficiencies:

- lack of stocked chlorine tablets,
- solids accumulation, and
- tablet drop failure (penciling, etc.).

The inspection form used on site to record these data is available from the National Onsite Demonstration Program [1].

Of the 419 units, field inspectors reported 272 units (65 percent) as having one or more total deficiencies, and 147 units (35 percent) as having no apparent deficiencies (table 7a). Of the 419 units inspected, 85 were sampled for laboratory analyses. A similar percentage of the 85 sampled units (71 percent) were identified as having one or more total deficiencies.

Using laboratory data, the percentage of units exceeding grab sample limits for TSS, FC, and BOD₅ was examined as a function of the presence/absence of total deficiencies (table 7b). Of the 419 units, chlorination deficiencies were examined as a measure of the presence/absence of total deficiencies (table 7a). Of the 419 units inspected, 85 were sampled for laboratory analyses. A similar percentage of the 85 sampled units (71 percent) were identified as having one or more total deficiencies.

Using laboratory data, the percentage of units exceeding grab sample limits for TSS, FC, and BOD₅ was examined as a function of the presence/absence of total deficiencies (table 7b). Of the 419 units, chlorination deficiencies were examined as a measure of the presence/absence of total deficiencies (table 7a). Of the 419 units inspected, 85 were sampled for laboratory analyses. A similar percentage of the 85 sampled units (71 percent) were identified as having one or more total deficiencies.

### Table 5

**Chlorine Residual of All Units**

<table>
<thead>
<tr>
<th>Description</th>
<th># of Units</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine absent</td>
<td>102</td>
<td>68%</td>
</tr>
<tr>
<td>Chlorine present</td>
<td>47</td>
<td>32%</td>
</tr>
<tr>
<td>Total ATUs</td>
<td>149</td>
<td>100%</td>
</tr>
<tr>
<td>Chlorine data not availible</td>
<td>270</td>
<td></td>
</tr>
</tbody>
</table>

### Table 6

**Turbidity of All Units**

<table>
<thead>
<tr>
<th>Turbidity</th>
<th># of Units</th>
<th>% of Values Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0–25.0</td>
<td>54</td>
<td>37%</td>
</tr>
<tr>
<td>25.1–50.0</td>
<td>36</td>
<td>24%</td>
</tr>
<tr>
<td>50.1–75.0</td>
<td>16</td>
<td>11%</td>
</tr>
<tr>
<td>75.1–100.0</td>
<td>10</td>
<td>7%</td>
</tr>
<tr>
<td>100.1–200.0</td>
<td>18</td>
<td>12%</td>
</tr>
<tr>
<td>&gt;200.0</td>
<td>14</td>
<td>9%</td>
</tr>
<tr>
<td>Total ATUs</td>
<td>184</td>
<td>100%</td>
</tr>
<tr>
<td>Turbidity data not available</td>
<td>271</td>
<td></td>
</tr>
</tbody>
</table>

### Table 7a

**Total Maintenance Deficiencies*|

<table>
<thead>
<tr>
<th>Deficiencies</th>
<th>Field Data</th>
<th>Lab Data</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Units</td>
<td>Percentage</td>
<td># of Units</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>Units with a deficiency</td>
<td>272</td>
<td>65%</td>
</tr>
<tr>
<td>Units with no deficiency</td>
<td>147</td>
<td>35%</td>
</tr>
<tr>
<td>Total units</td>
<td>419</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Total Deficiencies = ATU maintenance deficiencies + chlorination deficiencies

### Table 7b

**Percentage of Laboratory Samples with or without Total Maintenance Deficiencies Exceeding Proposed WV DEP/OWR Grab Sample Limitations*|

<table>
<thead>
<tr>
<th>TSS</th>
<th>% Exceeding Grab Sample Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC</td>
<td>BOD₅</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>Units with a deficiency</td>
<td>33</td>
</tr>
<tr>
<td>Units with no deficiency</td>
<td>12</td>
</tr>
</tbody>
</table>

*see table 1
ATU Maintenance Deficiencies Identified by Inspectors

<table>
<thead>
<tr>
<th>Maintenance Deficiencies</th>
<th>Field Data</th>
<th>Lab Data</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Units</td>
<td>Percentage</td>
<td># of Units</td>
</tr>
<tr>
<td>Maintenance deficiency</td>
<td>135</td>
<td>32%</td>
</tr>
<tr>
<td>No maintenance deficiency</td>
<td>284</td>
<td>68%</td>
</tr>
<tr>
<td>Total units</td>
<td>419</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 8a

Percentage of Laboratory Samples with or without ATU Maintenance Deficiencies Exceeding Proposed WV DEP/OWR Grab Sample Limitations*

<table>
<thead>
<tr>
<th>Maintenance Deficiencies</th>
<th>% Exceeding Grab Sample Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>BOD₅</td>
</tr>
<tr>
<td>Maintenance deficiency</td>
<td>41</td>
</tr>
<tr>
<td>No maintenance deficiency</td>
<td>18</td>
</tr>
</tbody>
</table>

*see table 1

Maintenance Deficiencies

ATU maintenance deficiencies were separated from chlorinator deficiencies because the same brand of ATU frequently employs different chlorinator designs. The following ATU maintenance deficiencies were included on the inspection form:

• access to the unit,
• surface drainage around and into the unit,
• weeds and debris around the unit,
• aerator malfunctions and blow/air line malfunctions,
• roll in the aeration chamber,
• septic solids/odor in the aeration chamber,
• wiring/power of the unit,
• access to the control panel,
• wiring/power to the control panel,
• floating solids in the settling compartment,
• excessive scum in the settling compartment, and
• clarity, color, and odor of the effluent.

Field inspectors reported that 135 units (32 percent) had one or more ATU maintenance deficiencies (table 8a), and 284 units (68 percent) had no identifiable ATU maintenance deficiency. The most common ATU deficiencies identified in the field were septic solids in the aeration chamber, aerator malfunctions, floating solids in the settling chamber, and odor of the effluent.

When maintenance deficiencies were present, a much larger percentage of units exceeded the proposed limitations for TSS (41 percent compared with 18 percent) and BOD₅ (59 percent compared with 27 percent) (table 8b). This suggests that regular maintenance would contribute to a significant performance improvement for the ATU. In addition, units with no maintenance deficiency exceeded TSS and/or BOD₅ 31 percent of the time. This suggests that factors other than those indicated by the inspections may be contributing to failure. Further study is recommended to identify additional factors responsible for poor performance.

Chlorination Deficiencies

Field inspectors reported that 215 units (51 percent) had one or more ATU chlorination deficiencies and 204 units (49 percent) had no identifiable ATU chlorination deficiencies (table 9a). Of these units, 29 percent exceeded the grab sample limits for TSS, 96 percent for FC, 46 percent for BOD₅, and 98 percent for at least one of these limits (table 9b). Chlorination deficiency types are listed in table 10.

*Some of the 215 total units with chlorination deficiencies showed more than one deficiency type.
Access to the chlorinator could not always be obtained for various reasons. These units were not considered to have a chlorination deficiency because field inspectors did not clearly indicate how many chlorinators appeared to be working correctly. Thus, the actual percentage of chlorination deficiencies may be an underestimate (tables 9a, 9b, and 10).

FC limits were exceeded in 81 percent of sampled West Virginia ATU systems even when no chlorination deficiency was reported (table 9b). These data strongly suggest that current disinfection methods employed with West Virginia ATUs are inadequate and should be critically examined.

Three main chlorination deficiencies were included on the inspection. These were 1) solids accumulation in the chlorinator, 2) lack of stacking of chlorine tablets, and 3) tablet drop failure (chlorine tablets were not in contact with the effluent). Of the deficiencies that were reported, 42 percent were a result of tablet drop failure (table 10). Thirty-nine percent of the chlorination deficiencies were due to a lack of stacking of chlorine tablets. These two chlorination deficiencies accounted for more than 80 percent of the total chlorination deficiencies. The remaining 19 percent of chlorination deficiencies were due to solids accumulation in the chlorinator.

Other problems were encountered with chlorination, including soggy chlorine tablets, wrong type and size of chlorine tablets, broken and missing caps and chlorine feeder tubes, chlorine feeder tubes knocked over or misaligned, chlorinators off level, water bypassing the chlorinators, and no chlorinators at all. However, these problems were infrequent compared to the three main deficiencies.

Homeowner Satisfaction Interview

More than 200 homeowners responded to interview questions concerning the performance of their ATU system. Malfunctions reported included motor malfunctions, clogged filters, excessive hair buildup on aerator shafts, solids accumulation, excessive foam spilling from the unit, and odor problems. Some homeowners also expressed dissatisfaction in getting their systems serviced. Few West Virginia homeowners reported that they had their units pumped regularly. Despite these problems, the majority of homeowners (85 percent) reported being either "satisfied" or "very satisfied" with their ATU system (table 11).

Results of the present study suggest that many ATU systems produce effluents of unacceptable quality. Since the satisfaction of homeowners is high and the actual performance of the ATU systems is comparatively low, public education of homeowners will be needed to make any changes in policies regulating ATUs.

DISCUSSION

A recent Texas report (Blount, 1997) reported significantly different results from those obtained in the present study. In the Texas report, only a small range of units (1.5 to 7.8 percent) failed to comply with the Texas state regulations for BOD$\text{$_5$}$ and TSS of 65 mg/L. In this West Virginia study, 47 percent of the units exceeded limitations for BOD$\text{$_5$}$ or for TSS of 75 mg/L. West Virginia ATUs may have less pretreatment capacity than Texas ATUs, causing inadequate flow equalization and settling. Pretreatment tanks of 500 to 800 gallons are typically required in Texas but are not required in West Virginia.

A second significant difference is the amount of maintenance required by the two states. Texas requires quarterly maintenance including settleability and total solids field tests, as well as annual independent lab testing of all units. Texas ATUs are monitored, inspected, and maintained more frequently than those in West Virginia. By contrast, West Virginia requires only an initial two-year maintenance program in which the units receive maintenance twice a year for two years. Settleability and total solids testing is not routinely done in West Virginia on ATUs, even during the initial two-year maintenance period. The Texas report suggests that additional pretreatment and/or maintenance of West Virginia ATU systems is needed.

Cost may be a factor in the lack of maintenance of West Virginia ATUs. The cost of ATU operation and semiannual maintenance is estimated to be $27 per month in West Virginia. This includes the estimated cost of electricity to operate the unit at $10 per month and $17 per month for inspection visits and necessary pumping. If monitoring of units were to be required quarterly in West Virginia, the operational cost would likely increase to approximately $37 per month.

Nearly 90 percent of the West Virginia ATUs examined produced effluent of unacceptable sanitary quality as measured by FC counts. It appears that most units do not provide for adequate disinfection. Tablet chlorinators often were not stocked, or the tablet would get stuck in the tube and out of the effluent stream (tablet drop failure). Overall, very few tablet chlorinators worked properly and provided the required amount of free chlorine residual in the discharged effluent.

CONCLUSIONS

- Ninety-two percent of West Virginia ATU systems appear to be discharging effluent of unacceptable quality.
- Disinfection of effluent appears to be inadequate and must be improved to avoid potential public health threats.
- Maintenance problems with West Virginia ATU systems are common and safeguards to ensure effective continuous operation of the systems should be implemented.
- West Virginia ATU systems with no maintenance deficiency exceeded TSS and/or BOD$\text{$_5$}$ limits 31 percent of the time. This suggests that factors other than those indicated by the inspections may be contributing to failure. Further study is recommended to identify additional factors responsible for poor performance.
- The data suggest that mandatory lifetime maintenance should

<table>
<thead>
<tr>
<th>Table 11: Homeowner Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
</tr>
<tr>
<td>1 (unsatisfied)</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5 (very satisfied)</td>
</tr>
<tr>
<td>Total homeowners responding</td>
</tr>
</tbody>
</table>
be required for West Virginia ATU systems.

- There is a pronounced difference between the positive public perception of West Virginia ATU systems effectiveness and their actual performance.

Because the satisfaction of homeowners is high and the actual performance of the West Virginia ATU systems is comparatively low, public education of homeowners will be needed to make any changes in policies regulating West Virginia ATUs.

Turbidity of effluent was not an acceptable indicator of compliance.

FC limits were exceeded in 81 percent of sampled West Virginia ATU systems even when no chlorination deficiency was reported (table 9b). These data strongly suggest that current disinfection methods employed with West Virginia ATUs are inadequate and should be critically examined.

NOTE
1. Copies of the questionnaire and onsite inspection form used in the West Virginia ATU survey can be obtained from the National Onsite Demonstration Program, West Virginia University, P.O. Box 6064, Morgantown, WV 26506-6064. Or call (304) 293-4191 or (800) 624-8301.

REFERENCES


Kelly Fleming (M.S.), Krista Kinneer (M.S.), and Ed Winant (Ph.D.) of West Virginia University assisted the project in the lab, in the field, and with writing this report.

Acknowledgements

The assistance of Cabell, Kanawha, Lincoln, Jackson, Marion, and Monongalia county health departments and the West Virginia Bureau of Public Health with survey development, field inspection, and sampling is gratefully acknowledged. The authors thank members of the ATU Survey Advisory Group and other reviewers for critically reading this report prior to publication. A full list of survey participants is available from the authors. Homeowners who took time to complete the ATU survey and allowed access to their units made this study possible.

Mike Aiton works as a program coordinator for the National Onsite Demonstration Program at West Virginia University (WVU). During his 15-year tenure at the university, Mike has worked for the National Small Flows Clearinghouse and helped to establish the National Environmental Training Center for Small Communities. He also is pursuing his J.D. at WVU’s College of Law.

Gary K. Bissonnette is a professor of environmental microbiology in the Division of Plant and Soil Sciences at West Virginia University. Dr. Bissonnette received M.S. and Ph.D. degrees from Montana State University. His research efforts focus on the microbiology of drinking water and wastewater, especially as related to the detection of microorganisms of public health significance.

The authors thank members of the ATU Survey Advisory Group and other reviewers for critically reading this report prior to publication. A full list of survey participants is available from the authors. Homeowners who took time to complete the ATU survey and allowed access to their units made this study possible.

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1. Manuscripts should be double-spaced and printed on 8.5 by 11-inch paper.
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3. Authors are requested to follow the general style guidelines given in the Chicago Manual of Style, 14th Edition, or the ASAE Guide for Refereed Publications, Monographs, and Textbooks when preparing text, tables, and figures. The ASAE guide is available online at http://www.asae.org/pub/style.html, or simply contact Cathleen Falvey, the juried articles editor, at (800) 624-8301, ext. 5526, for help and information.
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Gravelless System and Chamber System

What is the difference between a gravelless system and a chamber system?

A gravelless system is essentially what its name suggests—an onsite system that does not use a gravel media in its leachfield trenches or beds. A conventional onsite wastewater treatment system uses gravel to support the sidewalls in a drainfield trench to provide storage of peak wastewater flows and a media for the wastewater to flow through before reaching the infiltrative surface. A gravelless system uses nongravel materials (rubber, sand, fiber membrane, plastic, glass, or wrapped or slitted corrugated plastic pipe) as media in the drainfield’s soil absorption trenches. The wrapped or slitted corrugated pipe is usually an 8- or 10-inch (inside diameter) plastic pipe.

These nongravel materials are installed surrounding the leachfield distribution pipes in the soil absorption trench. The depth of these trenches is dependent upon state and local regulations. Effluent loading rates and distribution methods in the gravelless system follow the same principles used in gravel systems.

A chamber system is like a gravelless system in that it does not use any media or aggregate in the trench bottom or leaching bed. The “chamber” is formed by a structure that is open at the bottom and may have a variety of sidewall configurations. These systems can be made of several different materials ranging from plastic and fiberglass to block or brick structures.

The use of gravelless or chambered system technologies eliminates the potential drawback of gravel as a negative system component. For example, the introduction of “fines” or dust into the leaching system with the use of gravel may create clogging within the leaching area. Eliminating gravel also removes the threat of soil compaction in the trench or bed. These technologies offer ease of construction and inspection and provide a higher storage capacity when wastewater generation exceeds infiltration.

When is a gravelless or chamber system appropriate?

Either of these systems can be used whenever a trench or a bed can be used. Like a conventional system, these technologies can be used on almost any slope and under most conditions. The only difference is that these systems use a support structure to maintain an underground void that allows for storage of the wastewater and for subsurface aeration within the drainfield trenches. As with conventional systems, the soil type and characteristics, as well as depth to water table and other factors, such as vertical and horizontal separation distances, control the use and acceptance of these alternative systems.

Studies have shown that these technologies perform somewhat better than conventional...
<table>
<thead>
<tr>
<th>State</th>
<th>Gravelless System Allowed</th>
<th>Chamber System Allowed</th>
<th>Reduction Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Alaska</td>
<td>Yes</td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td>Arizona</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Arkansas</td>
<td>Yes</td>
<td></td>
<td>Some reduction is allowed</td>
</tr>
<tr>
<td>Colorado</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Connecticut</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
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<td>Delaware</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Florida</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Georgia</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes for chamber systems; none for gravelless systems</td>
</tr>
<tr>
<td>Hawaii</td>
<td>No</td>
<td>Yes</td>
<td>17-20% for specific manufacturers of chamber systems</td>
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<td>Idaho</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Illinois</td>
<td>Yes</td>
<td>Yes</td>
<td>County-by-county approval for chamber systems</td>
</tr>
<tr>
<td>Indiana</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Iowa</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes for chamber systems: 8-inch gravelless pipe requires additional 20% length, and 10-inch gravelless pipe receives 24-inch wide credit</td>
</tr>
<tr>
<td>Kansas</td>
<td>Yes</td>
<td>No</td>
<td>Yes for chamber systems on a county-by-county approval process</td>
</tr>
<tr>
<td>Kentucky</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes for chamber systems; no reduction for 8-inch diameter gravelless, and 30% reduction on 10-inch as experimental only</td>
</tr>
<tr>
<td>Louisiana</td>
<td>Yes</td>
<td>Yes</td>
<td>Some reduction is allowed</td>
</tr>
<tr>
<td>Maine</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Maryland</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Massachusetts</td>
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<td>Yes</td>
<td>Yes</td>
</tr>
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<td>Minnesota</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes for chamber systems</td>
</tr>
<tr>
<td>Mississippi</td>
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<td>Yes</td>
<td>Yes for chamber systems</td>
</tr>
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<td>Missouri</td>
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<td>Yes</td>
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</tr>
<tr>
<td>Nebraska</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Nevada</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>Yes</td>
<td>Yes Approved on product-specific basis</td>
<td>Yes for chamber systems; gravelless-sizing is product-specific</td>
</tr>
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<td>New Jersey</td>
<td>Yes</td>
<td>Yes</td>
<td>Sizing is product-specific</td>
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<tr>
<td>New York</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>North Carolina</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes for chamber systems</td>
</tr>
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<td>North Dakota</td>
<td>Yes</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>Ohio</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>Yes</td>
<td>Yes</td>
<td>Some reduction is allowed</td>
</tr>
<tr>
<td>Oregon</td>
<td>Yes</td>
<td>Yes</td>
<td>Some reduction is allowed</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>Being used only under experimentation</td>
<td>Yes</td>
<td>Yes for chamber systems</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>No</td>
<td>Yes</td>
<td>Yes for chamber systems in trenches and repairs only</td>
</tr>
<tr>
<td>South Carolina</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes for chamber systems under the Provisional and Demonstration Protocol</td>
</tr>
<tr>
<td>South Dakota</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes for chamber systems</td>
</tr>
<tr>
<td>Tennessee</td>
<td>No</td>
<td>Yes</td>
<td>Yes for standard chamber systems</td>
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<td>Yes</td>
<td>Yes for chamber systems and gravelless systems</td>
</tr>
<tr>
<td>Utah</td>
<td>Yes</td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td>Vermont</td>
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<td>Yes</td>
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</tr>
<tr>
<td>Virginia</td>
<td>Yes</td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td>Washington</td>
<td>Yes</td>
<td>Yes</td>
<td>Reductions based on soil condition</td>
</tr>
<tr>
<td>West Virginia</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes for chamber systems; gravelless receives no reduction</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>Yes</td>
<td>Yes</td>
<td>Some reduction is allowed</td>
</tr>
<tr>
<td>Wyoming</td>
<td>Yes</td>
<td>No</td>
<td>Some reduction is allowed</td>
</tr>
</tbody>
</table>

Gravelless systems. However, there is some concern that, over time, the gravelless technologies may percolate the same as a conventional system due to the slime layer that builds up on the infiltrative surface. It is important to realize that gravelless technologies operate on the same principles as conventional systems.

The table on the left lists states that have provided information on the approval of use for gravelless or chambered technologies.

Because regulations change frequently, it is necessary to contact your regulatory authority to ensure that these systems are approved.

**NSFC Resources**

Gravelless Drainfields Technology Package is a compilation of articles describes the advantages of gravelless trenches and chamber systems over conventional gravel-filled trenches. The package contains several papers, abstracts of articles from the NSFC Bibliographic Database, case studies, and product information. The information is geared toward engineers, researchers, state regulatory agencies, state and public health officials, contractors/developers, and planners. The price for this 68-page book is $9.80. Additional shipping charges apply. Request Item #WKBKGN74.

Alternative Onsite Systems Technology Package was developed by the NSFC. This package is designed to inform homeowners of the many alternative onsite wastewater technologies that can be used in areas not suitable for the conventional septic tank and drainfield. Each technology listed in this package is given a brief overview. The package is useful for the general public, community planners, and local, state, and public health officials. The price for this 66-page book is $5. Additional shipping charges apply. Request Item #WWPKGN87.

Editor’s Note: This column is based on calls received over the National Small Flows Clearinghouse (NSFC) technical assistance hotline. If you have further questions concerning gravelless or chamber systems, call (800) 624-8301 or (304) 293-4191 and ask to speak with a technical assistance specialist.
CONTINUED FROM PAGE 15

Burnett as a Training Center

Because Burnett was close to the NOWTC in Puyallup, “the project could be used as a site for training center attendees,” said Steve Arek, public health manager for the Source Protection Program at the Tacoma-Pierce County Health Department. “Attendees can observe the operation of a wide variety of alternative systems under field conditions.”

Said Stonebridge, “Nationally, Burnett will demonstrate a risk management approach to siting, design, and maintenance of onsite wastewater treatment systems.”

NODP Phase II Systems at Burnett, Washington

“Several interesting designs were done in this project. A number of different technologies were demonstrated for primary, secondary, and polishing of domestic wastewater,” said Solomon.

System 1: septic tank with recirculating gravel filter.
System 2: two-compartment septic tank with FAST (fixed activated sludge treatment) unit and subsurface drip disposal with pressure compensating emitters.
System 3: aerobic treatment unit (ATU) and raised-bed chamber system.
System 4: septic tank; Waterloo Biofilter; and shallow gravel bed disposal.
System 5: ATU to subsurface drip disposal with pressure compensating emitters.
System 6: septic tank, peat biofilter, and shallow gravel bed.
System 7: septic tank with mound (6-inch pea gravel, 15-inch ASTM C-33 sand, 6-inch drain rock) soil disposal component.
System 8: septic tank, Reactex filter, and sand filter unit.
System 9: 1,000-gallon septic tank subsurface drip with pressure compensating emitters.
System 10: 1,000-gallon septic tank, chamber in shallow trenches, and gravity flow with equal distribution.
System 11: septic tank/pump; at grade pressure lateral with Hydrotech valve, trench ASTM C-33 sand.
System 12: septic tank and chambers and gravel trenches.
System 13: septic tank; constructed wetlands; and chambers (gravity feed).
System 14: septic tank and surge/equalization tank; bottomless stratiﬁed sand filter.
System 15: septic tank, surge/equalization tank, and Glendon BioFilter Technology BioFilter.

“The demonstration project in Burnett, Washington, was not just a pipe project but a total community empowerment project as well,” said Solomon. “The credit also goes to the various stakeholders who did more than what was required.” These stakeholders are the Washington State Department of Health, the Pierce County Department of Community Service, the Washington Onsite Sewage Association, and the Tacoma-Pierce County Health Department.

“Phase II of NODP will have accomplished its mission soon,” said Solomon, “which was to initiate the design, installation, and preliminary monitoring of alternative onsite systems. It’s time for more detailed studies to be conducted by research institutions and other organizations to pick up where we ended.”

For information about the Burnett project, contact Stonebridge at (360) 331-6101. For information about NODP II, call Solomon at (800) 624-8301 or (304) 293-4191.
Letters to the Editor

| CONTINUED FROM PAGE 4 |

map would have us think there are none in the eastern half of the U.S. (Wrong.) You may have a chance, in future articles, to print better maps, perhaps of smaller areas, and larger scale, and more accurate. I hope so. Maps are useful, but they must be good, readable maps.

On page 16, the author notes that “water systems are... often located in arid regions where water sources are difficult to obtain.” This is followed by a page on Arctic conditions where the cold temperatures are the chief problem to overcome. Yes, Native People live in deserts and tundra (and other places). But it appears there is a bigger problem, and it relates to “thinking inside a box.” It appears that the U.S. Environmental Protection Agency (the “pocket” where the money comes from) is “wedded” to the flush toilet for all conditions, whether desert dry or permafrost cold. One of the biggest problems I see in the whole issue of human waste disposal is the blindness that assumes that the flush toilet is the only way to go, and nothing else needs to be said about it.

Consider the conditions of the arid western states, where the largest numbers of Native Americans reside and the largest reservations are located: both surface water and groundwater usually are in short supply, and drinking water is the critical need for human life. The flush toilet actually wastes water precisely in those places where water should not be wasted. Is this environmentally sound? Is this economically sound? Where is the consideration of dry toilets, or composting toilets, or other “alternative” disposal systems?

Some people will come back with a terse, but shallow answer, “cost,” and will examine the issue no further. But everything that is built, even a low-maintenance system, has several costs: a) immediate capital construction costs, b) ongoing operation and maintenance costs, and c) environmental costs (which can include economic and social costs). For the costs of sewer lines and sewage treatment plants (with all three kinds of costs), alternative technology could be implemented that would conserve valuable drinking water supplies, avoid environmental damages (such as contamination), and allow Native Americans and Alaskan Natives the freedom they always have enjoyed, to move around from place to place.

Your Small Flows Quarterly would be doing generations of North American people a tremendous favor by pointing out to EPA/ESTD (Environmental Services and Training Division) people that they need to “think outside the box,” and realize that the flush toilet is not the only answer and is not necessarily the best answer to human waste disposal. They should consider, in each case, the “green” or environmentally and economically sound alternatives to the water-wasting flush toilet. They should engage in what is termed “life-cycle costing” of any system design. There is alternative technology, and it is especially valuable in desert and tundra environments. Alas, there is no mention of this in the article. If ESTD people discuss alternatives with Native American people, it needs to be mentioned in future articles.

Thanks for letting me “sound off” in your direction. (P.S. I am employed as a planner in a state water resources program. I have been a planner for 31 years, in New York, Massachusetts, and Missouri. I also have lived in New Mexico and Oklahoma. My wife is Cherokee, from Oklahoma.)

Sincerely yours,
Richard Bounding Elk,
aka Richard M. Gaffney
Abenaki Indian

Dear Editor,

I found the Spring issue of the Small Flows Quarterly interesting and would like to comment on several articles.

The article on flow rate and waste strength is very good, but misleading since it uses ancient tables from a publication almost 30 years old. Having once worked in a regulatory agency for 15 years reviewing permit applications for various wastewater treatment systems, I think I can assure you that anyone submitting an application for a treatment system treating wastewater from a restaurant having a biochemical oxygen demand (BOD) of only 450 would soon have his submittal returned to him. Experienced engineers who have actually sampled influent from restaurants rarely design for anything less than a BOD of 1,000, and usually for a BOD of 1,200.

Hospitals and funeral homes also rarely have a BOD of 200 because of blood in the wastewater. If you ever designed a system for a small butcher shop, you soon learned the “rule of thumb” that one gallon of blood equals one thousand gallons of sewage based on BOD. Hospitals also usually have silver in their wastewater, which may be toxic to anaerobic bacteria in a septic system.

Another hint—laundromats—always have dual quarter-inch removable screens somewhere in the system or the system will plug up with lint. If you don’t have the screens or if they are not cleaned daily, you will be sorry. If you block up your sand filter with lint, you can try dosing with several gallons of industrial strength sodium hydroxide from a plumber supply house.

The article on infrared technology brought back memories. Having been a machine gunner on one of the three FLIR (forward-looking infrared) gunships used in Vietnam, I must warn you that heat readings in shallow water can be very misleading. Shallow water warms faster than deeper water, and therefore water along the edge of a shallow lake would normally be expected to look different on the infrared screen even without sewage being discharged. We used to have a very difficult time finding freshly buried landmines, and we had a much greater difference in temperature than that expected between sewage seeps and lake water. Interpreting what is shown on an infrared screen or pictures takes experience; slightly exposed sandbars, for example, retain the heat of a sunny day for a long, long time.

Sincerely,
Al Sever, P.E.
Montoursville, Pennsylvania
Free Newsletter Discusses Alternative Toilets

Homeowners, local officials, and others who want to learn about alternative toilets will appreciate the newsletter Pipeline.

Published by the National Small Flows Clearinghouse (NSFC), Pipeline is written for a general audience, and each issue explains a wastewater technology or theme of interest to local officials and community residents. The articles are presented in an easy-to-read non-technical style and include a list of contacts and resources in each issue.

Alternative toilets are the focus of the Summer 2000 Pipeline (Item #SFPLNL22), which describes various alternative toilets that can be used in homes and public restroom facilities. The newsletter discusses operation and maintenance, plus advantages and disadvantages of each. This Pipeline includes two case studies that show how alternative toilet systems helped to resolve wastewater disposal problems.

The Pipeline newsletter may be downloaded from NSFC’s Web site as well. Located at www.nsfc.wvu.edu, the NSFC Web site also contains information about new wastewater-related products, NSFC services, and a calendar of upcoming conferences and events.

Readers are encouraged to reprint Pipeline articles in local newspapers or include them in flyers, newsletters, or educational presentations. Pipeline can also be ordered in bulk and distributed at public meetings or other forums.

To order a particular Pipeline issue or for a free subscription, call the NSFC at (800) 624-8301 or (304) 293-4191, or write to NSFC, West Virginia University, P.O. Box 6064, Morgantown, WV 26506-6064. The international subscription fee is $6.00. All back issues of Pipeline cost 20 cents each, and shipping charges apply.

Past Issues of The Small Flows Journal Now Available on NSFC’s Web Site

The National Small Flows Clearinghouse (NSFC) recently added a new section to its Web site for archives of past issues of The Small Flows Journal. These issues are no longer available in print and can only be downloaded from this site. The URL for The Small Flows Journal Archives page is www.estd.wvu.edu/nsfc/NSFC_SFJarchives.html.

When it was in publication, The Small Flows Journal was the only peer-reviewed technical journal devoted specifically to the study of onsite and small community wastewater issues. Its articles encompassed aspects of engineering, planning, water quality, and public administration.

Now these peer-reviewed technical articles are included as a section within NSFC’s new magazine, Small Flows Quarterly. NSFC’s Archives Web page contains back issues of The Small Flows Journal before it was combined with the Small Flows Quarterly magazine. Future issues of the journal will be archived with this new magazine.

The latest issues of Small Flows Quarterly and NSFC’s newsletter, Pipeline, may be downloaded from NSFC’s Web site as well. In addition, the NSFC Web site includes information about new wastewater-related products, NSFC services, and related projects, such as the National Onsite Demonstration Program.

Located at www.nsfc.wvu.edu, the site also contains a public education section called “Wastewater Notes” and a listing of upcoming events. Those interested in finding out which conferences NSFC representatives will attend can access that information on the “Calendar of Events” page.

Also included are links to the NSFC’s “sister” organizations, the National Drinking Water Clearinghouse and the National Environmental Training Center for Small Communities, which also have their own publications On Tap, Water Sense, and E-train online.
Polluted

Developed by the EPA Office of Water, this brochure folds out to graphically illustrate sources of runoff, such as forestry, agriculture, urban stormwater, household and automotive care, and construction. The brochure lists activities in which the community can participate to help reduce the impact of runoff and pollution entering nearby waterways. Regional EPA Nonpoint Source Coordinators are listed as sources of more information. This two-page foldout could be useful to local and state officials and the general public.

This brochure is free. Ask for Item #GNBRPE51.

Response to Congress on Privatization of Wastewater Facilities

Produced by the EPA Office of Water, this response was developed to address a U.S. House of Representatives Appropriations Committee’s request to examine the use of public/private partnerships as a source of funds to meet current and future wastewater infrastructure needs. The committee was concerned about the costs that local, state, and federal governments must finance to meet projected wastewater needs and the potential of the private sector to play a significant role in accomplishing this task. This booklet provides an overview of the wastewater public/private partnership process. It presents the most common partnership arrangements; the financial, non-financial, and other issues associated with privatization; the impediments to privatization; and several case studies of public/private partnership arrangements. This 39-page booklet may be helpful to local and state officials, managers, planners, and the general public.

The cost for this booklet is $5.65. Ask for Item #WWBLGN144.

Choices for Communities: Wastewater Management Options for Rural Areas

Written by Mike Hoover, Ph.D., from the North Carolina State University, College of Agriculture and Life Sciences, Waste Management Programs, this booklet discusses wastewater management options for rural communities. It begins with a history of onsite systems and discusses alternatives to centralized sewering, stressing that management, maintenance, and inspection are key. The dilemma for many rural communities is that they lack a wastewater infrastructure, but a centralized system is too difficult and costly to implement. Today, there are more wastewater treatment options for rural communities, including surface or subsurface land-based technologies or surface-water discharge systems. The booklet outlines steps to a community-needs assessment, including planning and economic aspects. Also discussed is the Clean Water Act of 1972 and what
effects it had on small communities. The booklet examines alternatives to the conventional septic system, alternative wastewater collection technologies, and land-based treatment and disposal technologies. Advantages and disadvantages are included. The cost-effectiveness of land-based technologies is discussed using case studies of several North Carolina towns. In addition, centralized and decentralized approaches are compared, based on a detailed analysis of costs by the EPA using a hypothetical rural community. This 16-page booklet can serve as a resource for local, state, and public health officials; engineers; finance officers; contractors/developers; managers; planners; researchers; and state regulatory agencies.

The cost for this booklet is 50 cents. Ask for Item #WWBLMG09.

**On-Site Wastewater Treatment Systems: Low-Pressure Dosing**

Written by Bruce Lesikar with the Texas A&M University Agricultural Extension Service, this fact sheet details the characteristics, advantages, disadvantages, maintenance, and costs of a low-pressure dosing system for residential domestic use. An illustration of low-pressure dosing system components is included, as well as a graphic depiction of how the system distributes wastewater into the soil several times a day. This two-page fact sheet may be useful to local, state, and public health officials; contractors/developers; and the general public.

The cost of this fact sheet is $1.00. Request Item #WWFSGN133.

**On-Site Wastewater Treatment Systems: Subsurface Drip Distribution**

Written by Bruce Lesikar with the Texas A&M University Agricultural Extension Service, this fact sheet details the characteristics, advantages, disadvantages, maintenance, and costs of a drip (irrigation) distribution system for residential domestic use. An illustration of subsurface drip system components is included, as well as a graphic depiction of how the system distributes wastewater uniformly in the lawn. This two-page fact sheet could be useful to local, state, and public health officials; contractors/developers; and the general public.

The cost of this fact sheet is $1.00. Ask for Item #WWFSGN132.

**Onsite Wastewater Treatment Systems: Spray Distribution**

Written by Bruce Lesikar of the Texas Agricultural Extension Service at Texas A&M University, this fact sheet gives an overview of spray distribution systems for residential domestic use. It explains how the technology works and what maintenance is required. Characteristics, advantages, disadvantages, and costs are included. This two-page fact sheet may be useful to local, state, and public health officials; contractors/developers; and the general public.

The cost for this fact sheet is $1.00. Ask for Item #WWFSGN134.

**The Problem with Shallow Disposal Systems**

In this 15-minute video about "Class V" injection wells, citizens and local officials in three communities reveal how chemical waste discharged to groundwater through shallow disposal systems contaminated their water resources and how it affected their communities. Produced by the EPA Office of Ground Water and Drinking Water, this video demonstrates that: 1) shallow disposal systems are a common, but often overlooked, source of dangerous industrial chemicals; 2) federal and state regulations are not enough to control this kind of pollution in a community; and 3) there are simple, preventive steps a community can take to reduce this serious threat to its water supply without closing businesses or going into debt. This video shows what three communities in Great Falls, Virginia; Espanola, New Mexico; and Missoula, Montana, did to remedy the contamination of their water supplies and prevent future pollution. It is available in both English and Spanish and is a good community education tool. To receive the Spanish version, contact Harriet Hubbard with the EPA at (202) 260-9554. This video may be of interest to local, state, and public health officials; state regulatory agencies; contractors/developers; engineers; managers; and finance officers.

This video is free. Ask for Item #WWVTPE50.

**Watershed Protection: A Statewide Approach**

Produced by the EPA Office of Water, this book is one of two watershed protection guides designed for state water quality managers and others involved in watershed-based activities as they adopt, implement, and evaluate watershed protection programs. It discusses the
premise of the watershed protection approach: that many water quality and ecosystem problems are best solved at the watershed level rather than at the individual waterbody or discharger level. This 81-page book could be useful to planners, local and state officials, and the general public.

This book is free. Ask for Item #GNBLGN14.

State of the Chesapeake Bay: A Report to the Citizens of the Bay Region

Developed by the Chesapeake Bay Program, this book is a report on the progress made to protect and restore the Chesapeake Bay. This 64,000 square-mile watershed is home to more than 3,000 species of plants and animals and at least 15.1 million people. The Chesapeake Bay Program partners have set clear goals for recovery through nutrient and toxic pollution reduction, as well as habitat protection and restoration, which have led to the return of bay grasses and cleaner water. This report highlights water quality conditions and the status of aquatic life. It explains the progress made to reduce the top four stressors on the bay system: excess nutrients, toxic pollution, air pollution, and landscape changes. Also discussed are the most recent policy decisions and goals that are driving the overall clean-up effort, along with new findings, innovative technologies, and some of the challenges beyond the year 2000. This 59-page book can be helpful to local, state, and public health officials and the general public.

This book is free. Ask for Item #WWBKPE54.

Environmental Indicators of Water Quality in the United States

Prepared by the EPA Office of Water, this report shows trends in water quality over time. It describes our nation’s water resources, human activities, and natural events, as well as their impact on water quality. The 18 indicators that will be used to measure progress toward water goals and objectives are also explained. These indicators are illustrated with graphs, charts, or maps and are categorized under one of five objectives: 1) conserve and enhance public health; 2) conserve and enhance aquatic ecosystems; 3) support uses designated by the states and tribes in their water quality standards; 4) conserve and improve ambient conditions; and 5) reduce or prevent pollutant loading and other stressors. This 28-page booklet could be useful to local, state, and public health officials; engineers; operators; state regulatory agencies; researchers; and the general public.

This booklet is free. Ask for Item #GNBLGN13.

National Estuary Program: Bringing Our Estuaries New Life

Developed by the EPA Office of Wetlands, Oceans, and Watersheds, this foldout poster highlights 21 local NEPs (National Estuary Programs). In 1987, the NEP was established to protect and restore the health of estuaries while supporting economic and recreational activities. Local NEPs developed partnerships between government agencies that oversee estuarine resources and the people who depend on the estuaries for their livelihood and quality of life. These groups plan and implement programs according to the needs of their areas. Each NEP demonstrates practical and innovative ways to revitalize and protect estuaries. This poster includes contacts for each local NEP. This two-page foldout could serve as a resource for local and state officials and the general public.

This poster is free. Ask for Item #GNPSPE52.

Water Pollution Control: Twenty-Five Years of Progress and Challenges for the New Millennium

Developed by the EPA Office of Water, this booklet discusses the Clean Water Action Plan and other ways to provide protection from public health threats posed by water pollution, including decentralized wastewater treatment (onsite) systems. In 1972, Congress passed the Clean Water Act (CWA) in response to public outrage over the deplorable condition of the nation’s waters. This report summarizes the progress and challenges of the CWA’s first 25 years, and what work remains to be done. The basic CWA approach has been greater control of “point sources” of water pollution—primarily factories and city sewers, along with control of activities that destroy wetlands. The report details ways in which federal law and policy have been continually strengthened to clean up America’s waters, including the National Pollutant Discharge Elimination System (NPDES) Program. Funding remains an important component of the CWA and its 1987 amendments in the form of the State Revolving Fund (SRF). Despite impressive
progress, states report that close to 40 percent of the waters they surveyed are too polluted for basic uses, such as fishing or swimming. New CWA focuses are more effective control of polluted runoff and promoting water quality protection on a watershed basis. This five-page booklet may be useful to local, state, and public health officials; managers; finance officers; state regulatory agencies; planners; operators; engineers; and the general public.

This booklet is free. Ask for Item #GNBLGN15.

Clean Water Action Plan: Restoring and Protecting America’s Waters

Prepared by the U.S. Department of Agriculture (USDA) and the EPA, this book details the Clean Water Action Plan, which was developed by the USDA and the EPA to meet the promise of clean, safe water to all Americans. The book explains how the action plan builds on the foundation of existing clean water programs, and it proposes new actions to strengthen efforts to restore and protect water resources. Under this plan, the federal government will support locally led partnerships, increase financial and technical assistance to states, and help states and tribes restore and sustain the health of aquatic systems. Factors such as regulation, economic incentives, technical assistance, education, and accurate information were identified as the necessary tools for restoring and protecting water resources. The book discusses how the goals of the Clean Water Action Plan can be achieved through a good watershed approach, strong federal and state standards, natural resources stewardship, and educating citizens and officials. This 101-page book can serve as a resource for local and state officials and the general public.

This book is free. Ask for Item #WWBKGN142.

On-Site Wastewater Treatment Systems: Conventional Septic Tank/Drain Field

Written by Bruce Lesikar with the Texas A&M University Agricultural Extension Service, this fact sheet details the costs, characteristics, advantages, disadvantages, and maintenance for a conventional septic tank soil absorption system for domestic residential use. This two-page fact sheet, which includes illustrations of a septic tank/soil absorption field and a two-compartment septic tank, may be useful to local, state, and public health officials; contractors/developers; and the general public.

The cost of this fact sheet is $1.00. Ask for Item #WWFSGN131.

Linear Regression for Nonpoint Source Pollution Analyses

Developed by the EPA Office of Water, this fact sheet is intended to demonstrate an approach to describing the relationship between variables using regression for nonpoint source pollution analyses. This fact sheet is targeted toward people in state water quality monitoring agencies who are responsible for nonpoint source assessments and implementing watershed management. In nonpoint source analyses, linear regression is often used to determine the extent to which the value of a water quality variable is influenced by land use or hydrologic factors, such as crop type, soil type, percentage of land treatment, rainfall, or stream flow, or by another water quality variable. Practical applications of these regression results include the ability to predict water quality impacts due to changes in the independent variables. This eight-page fact sheet could serve as a resource for engineers, state regulatory agencies, state officials, and public health officials.

This fact sheet is free. Ask for Item #WWBLRE30.

How Wastewater Treatment Works...The Basics

Developed by the EPA Office of Water, this trifold brochure describes the two basic stages in the treatment of wastewater: primary and secondary. The primary treatment section details bar screens, a grit chamber, a sedimentation tank, and raw primary biosolids (sludge). The secondary treatment section describes the trickling filter, activated sludge process, aeration tank, and disinfection. It also discusses other treatment options, including biological treatment capable of removing nitrogen and phosphorus; and physical-chemical separation techniques, such as carbon adsorption or reverse osmosis. This two-page brochure may be helpful to the general public.

This brochure is free. Ask for Item #WWBRPES5.

Funding Estuary Projects Using the Clean Water State Revolving Fund

Developed by the EPA Office of Water, this fact sheet outlines general information about funding estuary projects using the Clean Water State Revolving Fund (CWSRF), including who may qualify, its history, its financial capacity, the advantages of loans versus grants, sources of loan repayment, and challenges. To counteract the serious threats to estuaries across the country, EPA would like to see the CWSRF become a major source of funding for estuary protection. The 51 CWSRF programs currently issue approximately $3 billion annually in...
loans. SRF loans are issued at below-market rates (zero percent to less than market), offering borrowers significant savings over the life of the loan. The fact sheet discusses the National Estuary Program in relation to the SRF, and includes success stories of innovative CWSRF projects. This four-page fact sheet may be of interest to almost any wastewater professional, but particularly useful to local and state officials, state regulatory agencies, planners, managers, finance officers, public health officials, and the general public.

This fact sheet is free. Ask for Item #FM FSFN32.

Community-Based Environmental Protection: A Resource Book for Protecting Ecosystems and Communities

Developed by the EPA Office of Sustainable Ecosystems and Communities (OSEC), this book discusses how local communities play a prominent role in environmental protection and describes how recreational, economic, and other activities affect the quality of ecosystems. Protecting our nation’s ecosystems requires communities and individuals to conserve or restore habitats and help solve other environmental problems not specifically addressed by traditional regulatory approaches. This book draws on the experiences of many different communities to provide examples of community-based environmental programs. It also shows how other communities have assessed the interrelationships between their goals, such as residential development and ecosystem quality. Local and state officials, as well as the general public may find this 137-page book useful.

This book is free. Request Item #GNBKGN12.

Protecting Wetlands with the Clean Water State Revolving Fund

Developed by the EPA Office of Water, this fact sheet briefly outlines how the Clean Water State Revolving Fund (SRF) works, the various types of funding available (i.e., loans, grants), categories of eligibility, source of repayment, and where to obtain additional information. Based on the serious threats to wetlands resources across the country, EPA would like to see the SRF become a major source of funding for wetlands protection. The S1 Clean Water SRF programs currently issue approximately $3 billion in loans annually. SRF loans are issued at below market rates (zero percent to less than market), offering borrowers significant savings over the life of the loan. This two-page fact sheet may be of interest to local and state officials, planners, managers, finance officers, and the general public.

This fact sheet is free. Ask for Item #FM FSFN31.

Rural Community Assistance Program (RCAP) Help for Small Community Wastewater Projects

Developed by the EPA Office of Water, this fact sheet describes RCAP, a national network of nonprofit organizations, and how they provide on-site technical assistance to communities to help them attain or maintain adequate wastewater treatment services. The fact sheet discusses how, through a partnership agreement with the EPA, RCAP provides the appropriate financing, management, operation and maintenance, etc., through the Small Community Wastewater Project. The project addresses community-specific wastewater compliance problems, particularly compliance with the Clean Water Act requirements. This fact sheet discusses funding for small community wastewater projects and provides a contact for those who want more information. This two-page fact sheet could be of interest to local, state, and public health officials; state regulatory agencies; planners; managers; finance officers; contractors/developers; engineers; and the general public.

This fact sheet is free. Ask for Item #WW FSFN32.

Clean Water State Revolving Fund Program

Developed by the EPA Office of Water, this fact sheet describes the Clean Water State Revolving Fund (CWSRF) program that finances a range of environmental projects. Under the program, the EPA provides grants or “seed money” to capitalize state loan funds. The two-page fact sheet discusses how the states make loans to communities, individuals, and others for high-priority water-quality activities. As money is paid back into the revolving fund, the CWSRF makes new loans to other recipients who need help in maintaining water quality. This fact sheet discusses benefits, project eligibility, and summarizes the Clean Water Act. Local, state, and public health officials; state regulatory agencies; operators; contractors/developers; engineers; planners; managers; and finance officers will find this information particularly useful as they seek funding to correct or prevent water quality problems.

This fact sheet is free. Ask for Item #WW FSFN06.

To place an order...

To place an order, call the NSFC at (800) 624-8301 or (304) 293-4191, or use the order form on page 63 and fax your request to (304) 293-3161. You also may send e-mail to nsfc_orders@mail.estd.wvu.edu. Be prepared to give the item number and title of the
Products List

Item Number Breakdown

First two characters of item number: (Major Product Category)
- WW Wastewater
- FM Finance and Management
- GN General Information
- SF Small Flows

Second two characters of item number: (Document Type)
- BK Book, greater than 50 pages
- BL Booklet, less than 50 pages
- BR Brochure
- FS Fact Sheet
- JR Journal
- NL Newsletter
- PL Pipeline
- PK Packet
- PS Poster
- SW Software
- VT Video Tape

Third two characters of item number: (Content Type)
- CM Computer search
- CS Case Study
- DM Design
- FN Finance
- NL Newsletter
- OM Operation and Maintenance
- PE Public Education
- PP Public-Private Partnerships (P3)
- RE Research
- RG Regulations
- TR Training

Last two characters of item number: Uniquely identifies product within major category
- * Indicates changes in title, item number, and/or price
- □ Highlighted products are new

Case Studies

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<td>Vacuum Collection System (Cedar Rocks, West Virginia)</td>
<td>$1.30</td>
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<tr>
<td>WWBLCS03</td>
<td>Variable Grade Effluent Sewers (Maysville Area, Muskingum County, Ohio)</td>
<td>$1.90</td>
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<tr>
<td>WWBLCS04</td>
<td>Alternating Bed Soil Absorption Systems (Crystal Lakes, Colorado)</td>
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Abstracts of many products are provided in the NSFC's Products Guide. The guide may be downloaded via the NSFC's Web site at http://www.nsfc.wvu.edu.
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<td>WWBDLDM76 Mound Systems: Pressure Distribution of Wastewater Design and Construction In Ohio</td>
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- WWBKGN82 Greywater Technology Package ...................................................... $7.20*
- WWBKGN83 Site Evaluation Technology Package ...................................................... $12.95
- WWPKGN86 Nonpoint Pointers: Understanding and Managing Non-point Source Pollution In Your Community $0.00
- WWPKGN87 Alternative On-Site Systems Technology Package .................. $5.00*

**Training Materials**

- WWBKTR01 NPDES Compliance Inspection Training Program Student’s Guide $16.95*
- WWBLTR02 NPDES Compliance Inspection Video Workbook: Inspecting a Parshall Flume $4.05
- WWBKTR03 NPDES Compliance Monitoring Inspector Training—Sampling ........................................................................ $14.25
- WWBKTR04 NPDES Compliance Monitoring Inspector Training—Biomonitoring ................................................................ $10.80
- WWBKTR05 NPDES Compliance Monitoring Inspector Training—Overview ........................................................................ $12.35
- WWBKTR06 NPDES Compliance Monitoring Inspector Training—Legal Issues ........................................................................ $16.70
- WWBKTR07 NPDES Compliance Monitoring Inspector Training—Laboratory Analysis ...................................................... $20.00

**Videotapes**

- FMVTMG01 Wastewater Management in Unsewered Areas $10.00
- FMVTPE01 Building Support for Increasing User Fees (Videotape and Workbook) $12.60
- WWVTPE10 Monitollent, Arkansas, Land Application of Wastewater $10.00
- WWVTGN13 Alternative is Conservation $10.00
- WWVTGN117 Proper Treatment and Uses of Septage $15.00
- WWVTGN135 Septic Systems: Making the Best Use of Nature $10.00
- WWWTM136 Sampling Wastewater at a Wastewater Treatment Facility $10.00
- WWPVTE03 Sand Filter Technology $10.00
- WWPVTE04 Small Diameter Effluent Sewers $10.00
- WWPVTE05 Planning Wastewater Treatment for Small Communities $10.00
- WWPVTE06 Upgrading Small Community Wastewater Treatment $10.00
- WWVTPE13 Municipal Wastewater: America’s Forgotten Resources $15.00
- WWPVTE16 Your Septic System: A Guide for Homeowners $10.00
- WWPVTE22 Surface Water Video Loan
- WWPVTE23 Ground Water Video Adventure Loan
- WWPVTE24 Saving Water—The Conservation Video Loan
- WWPVTE25 Careers in Water Quality Loan
- WWPVTE29 Artificial Marshland Treatment Systems $10.00
- WWPVTE33 Water Conservation: Managing Our Precious Liquid Asset $13.50
- WWPVTE34 Keeping Our Shores/Protecting Minnesota Waters: Shoreland Best Management Practices $25.00
- WWPVTE40 Care and Feeding of Your Septic System $10.00
- WWPVTE42 Dollars Down the Drain: Caring for Your Septic Tank $10.00
- WWPVTE43 Septic Systems Revealed: Guide to Operation, Care and Maintenance $15.00
- WWPVTE45 Maintaining Your Home Aeration Sewage Treatment System $10.00
- WWPVTE47 Small Community Wastewater Treatment: Management and Myths $10.00
- WWPVTE48 Intermittent Sand Filter - State of the Art On-Site Wastewater Treatment $8.00
- WWPVTE49 PSM A Protocol: Inspecting On-Off Wastewater Treatment Systems $25.00
- WWPVTE50 Problem with Shallow Disposal Systems $10.00
- WWPVTE55 Choosing an Alternative Septic System $13.00
- WWPVTE60 Recirculating Filter On-Site Sewage Disposal System $10.00
- WWPVTE61 Conventional On-Site Sewage Disposal System $10.00
CONTINUED FROM PAGE 56

Funding Water Conservation and Reuse with the Clean Water State Revolving Fund

Developed by the U.S. EPA Office of Water, this fact sheet discusses the Clean Water Act (CWA) of 1987, which authorized the Clean Water State Revolving Fund (CWSRF) to finance point source, nonpoint source, and estuary projects. The programs work like banks: federal and state contributions are used to capitalize or set up the programs. These assets, in turn, are used to make low- or no-interest loans. Repaid funds are recycled to fund other water quality projects. This fact sheet describes how the CWSRF works, how to get a project funded, and the sources of loan repayments. Examples of successful projects are summarized. This two-page fact sheet could be useful to engineers, local and public health officials, operators, planners, finance officers, and the general public.

The cost is 30 cents. Ask for Item #FM FSFN35.

USDA Loan and Grant Funding for Small Community Wastewater Projects

This booklet by the U.S. EPA Office of Water provides general information about the U.S. Department of Agriculture Rural Utilities Service’s (RUS) Water and Waste Disposal Loans and Grants Program, including how RUS funding compares to joint funding sources and to EPA total need. Information is presented textually as well as graphically and in table form. The Water and Waste Disposal Loans and Grants Program provides loans and grants for water, sewer, stormwater, and solid waste disposal facilities. The program makes assistance available only to rural areas with 10,000 or fewer people. This eight-page booklet may be helpful to local, state, and public health officials; finance officers; managers; planners; and the general public.

The cost is $1.15. Ask for Item #FM BLFN 34.

Ordering Information

Phone: (800) 624-8301 or (304) 293-4191
Business hours are 8 a.m. to 5 p.m. Eastern Time.

E-mail: nsfc_orders@mail.estd.wvu.edu

Fax: (304) 293-3161

Mail:
National Small Flows Clearinghouse
West Virginia University
P.O. Box 6064
Morgantown, WV 26506-6064

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All payments must be in U.S. dollars using VISA, MasterCard, Discover, check, or money order.

To place your order using VISA, MasterCard, or Discover, include your credit card number, expiration date, and signature on the order form.

Make checks payable to West Virginia University.

Please allow two to four weeks for delivery.

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Products Order Form

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Model Program 1 is intended to raise the local regulatory agency’s awareness of the location of systems, raise homeowners’ awareness of basic system needs, and ensure homeowner compliance with basic maintenance requirements. This program also serves as a starting point for communities to have basic data that will help them determine if higher management levels are necessary.

• **Model Program 2—Management Through Maintenance Contracts:** EPA recommends this program where sites with limiting conditions, such as small lot sizes, or restrictive soil conditions (e.g., slowly permeable soils, shallow soils with limited treatment capacity, or high groundwater table) are encountered in a small portion of a community. These limiting conditions require improved effluent dispersal to the soil or additional treatment units, such as media filters or aerobic treatment units, and are typically operated through contracts with equipment vendors. Model Program 2, therefore, sets higher expectations for a regulatory program and for educating homeowners.

• **Model Program 3—Management Through Operating Permits:** This program is recommended by EPA in situations where the receiving environment indicates a need for advanced levels of treatment, such as an unconfined aquifer used as a drinking water supply or a fish spawning area. Model Program 3, consistent with the increasing risk, recommends setting measurable performance standards and ensuring compliance by issuing renewable operating permits that indicate specific performance criteria to be achieved. The regulatory agency monitors these systems for compliance with the performance criteria.

• **Model Program 4—Utility Operation and Maintenance:** This program is appropriately applied where engineered designs, such as aerobic treatment units, are required to overcome site, soil, or environmental conditions not conducive to conventional or alternative onsite technology. Frequent monitoring and maintenance is needed in these situations. Model Program 4 recommends that a public/private utility that is responsible for system performance provide operation and maintenance to ensure that maintenance needs are met.

• **Model Program 5—Utility Ownership and Management:** This program represents the management needs of a more complex program where a very high level of control is required due to environmental or public health concerns. Model Program 5 includes the public/private utility as the designated management entity that both owns and operates the onsite systems in a manner analogous to a publicly owned wastewater utility. This program is similar to the utility concept in Model Program 4. Under this level of management the utility maintains total control of all aspects of management—not just operation and maintenance.

We encourage everyone with an interest in onsite/decentralized wastewater systems to examine the proposed guidelines and offer their comments. Once a notice has been published in the Federal Register, the draft guidelines will be posted on EPA’s Web site. Printed copies will also be available for mailing. Comments can then be submitted electronically via the Web or by letter or fax. To be notified of the availability of the guidelines or to receive updated information about other decentralized wastewater activities, call EPA’s contractor, Lisa Knerr of TetraTech, at (703) 385-6000 ext. 169. For more information on the draft guidelines or other initiatives related to onsite/decentralized wastewater systems, visit EPA’s Web site at www.epa.gov/owm/decent.

Joyce Hudson is a senior environmental engineer with the EPA’s Office of Wastewater Management in Washington, D.C., and is involved in many aspects of its municipal wastewater technology program. She has been employed with EPA for the last 20 years and currently manages the agency’s effort to promote onsite/decentralized wastewater systems.
for assessing performance. Waiting until we can 1) install new side-by-side systems, 2) allow biotests to form, and 3) allow systems to mature before we answer each and every new question about system performance is not realistic.

But another approach, field performance surveys, can provide complementary research data from the side-by-side protocol. Statistically sound field performance surveys that evaluate random, stratified groups of hundreds of real systems under a broader range of environmental conditions can help the researcher extrapolate the results from the narrow set of conditions in an intensive side-by-side study. Field performance surveys can address a broader range of conditions (soils, climates, wastewater strengths and flows, as well as system design, installation, and operation variations) that represent reality in the field.

THE SCIENTIFIC METHOD AND REGULATORY DECISION MAKING

We have discussed the scientific method and how we need to build a much stronger scientific foundation as the basis for improving the quality and credibility of our decisions in the onsite field. But “pure” scientific method and studies are not enough in the world of practical regulatory decision making. Let’s turn to three other considerations that must complement the pure scientific method. Of these, let’s consider the broader context in which onsite science must work.

Our environmental values, not just science, determine performance standards. As we move toward a more performance- and treatment-based approach to regulation of onsite wastewater, we need to consider the same objectives as are needed in all other aspects of environmental protection: “how clean is clean” groundwater and surface water? Federal law and regulation, of course, have provided one set of answers, such as “fishable/swimmable” surface waters. States and localities will have to decide whether the federally defined objectives—or values—are sufficient. After those value decisions have been made, good science is necessary to determine whether products, technologies, management practices, or other pollution mitigation mechanisms are practical and sufficient to achieve the standards.

The American public does not make decisions on the basis of science alone. Almost all of us agree that a) we need treatment and performance standards, b) we need to get better at using scientific data in making decisions, and c) we need better enforceable procedures for management and maintenance of onsite systems.

Implementing what we agree on will require increased public expenditures, and therein lies the pickle. How, exactly, do I convince my Aunt Millie that she needs to spend money on a better system in order to protect the environment and more money on maintenance to ensure her system does not fail?

We think the beginning of the answer is that our environmental niche, onsite wastewater treatment, needs to see itself as being similar to all other environmental issues. Pollution is pollution. We need allies to address problems systematically. We need nongovernmental environmental groups—with their amazing historical ability to create public interest and support for addressing environmental problems—to share our values and commitment to improved onsite wastewater management.

There is never enough “pure” science to make perfect decisions. Since不久 after the first Earth Day, every environmental regulator has wished to have third-party, peer-reviewed, replicable, and published studies of every aspect of the pollution problem under consideration. Environmental protection, however, will not be quickly advanced—in the onsite field or any other—if the regulator waits on perfect scientific certainty. Therefore, we cannot let the perfect be the enemy of the good.

In most parts of environmental protection, a kind of informally accepted set of rules has evolved in response to this dilemma. The rules are collectively called, “acceptance of the scientific weight of evidence.”

Regulators should not and cannot afford to throw out data. Rather, they should put data into a hierarchy like the castle we used as an example. They can give, for instance, one weight to data supplied by a self-interested manufacturer; another weight to informal surveys by other regulators; still other emphasis to studies performed by non-academic third parties; weight to tests performed in somewhat different countries or climates; weight to laboratory studies versus field studies versus epidemiological studies; and so forth.

We in the onsite field must set higher standards for the scientific documentation we expect for product approval and other decisions. But, let’s also use all of the data at our disposal (imperfect as it may be) for making decisions, and accept that we will have to make judgments about the relative value or weight of these data.

As we discussed earlier, the scientific process resembles building a castle out of blocks. Each block is a study of some performance claim in which we are interested. What matters is whether there are enough blocks, of sufficient strength, to verify that a castle can stand.

And about the strength of the castle, you will have to make a judgment. As with practicing medicine, there will never be perfect certainty, but that should not keep you from making decisions or taking risks on new technologies. Just as in medicine, old remedies are often not the best remedies.

Yet despite the complications, science surely has to be the decision-making tool on which we need to rely in the future—-as already does the rest of environmental management. Any other castles are made out of sand.
Small Governments and the Regulatory Process

Steve Wilson

Editor’s Note: This is the second half of a two-part column dealing with small governments and environmental protection.

There are communities in the U.S. that are so small, so geographically isolated, so impoverished that they have neither the financial, technical, or managerial resources to meet even the basics established by national and state environmental laws.

That this is a national problem becomes obvious only when you step back and consider the numbers of people affected. According to the Census Bureau, as many as 61 million people live in rural areas where we might expect to find most of the country’s small towns.

Developing Regulations

Helping small communities comply with existing environmental laws and regulations is important, but only half of the equation. The other half involves small communities in the actual design of new regulations. The U.S. Environmental Protection Agency’s (EPA) program offices have long worked to involve small communities in the regulatory process.

Since 1996, EPA has stepped up these efforts by implementing the Small Business Regulatory Enforcement Flexibility Act (SBREFA) amendments to the Regulatory Flexibility Act. Simply put, these laws provide a process for involving small towns in the development of regulations.

Involving small communities in developing regulations turns out to be a very difficult thing—too early in the process, and there is little or nothing to talk about; too late in the process, and comments from small towns are likely to have little impact.

The other big problem is the demand on the time and energy of the individuals involved. If a part-time, small town mayor who must also make a living has difficulty keeping up with existing complex and technical environmental rules, imagine how difficult it is for that person to keep up with technical briefings, discussion papers, draft rules, and the like.

In order to find a solution to these and other problems, EPA has been experimenting with different ways to involve small towns. The Small Community Outreach Project for the Environment is one such project that involves small towns and local universities.

Policy Consultation

In 1996, EPA created the Small Community Advisory Subcommittee (SCAS) of the Local Government Advisory Committee. The specific objectives of the SCAS are to

- change the way EPA and state environmental agencies develop environmental regulations impacting small communities,
- effectively inform policy makers about the disproportionate costs of providing environmental protection for small communities, and
- encourage EPA, states, and third party providers to offer a range of technical assistance and professional services to small communities.

Although SBREFA can be an effective process for involving small communities in rulemaking, that involvement does not happen early enough to be effective. SCAS has found that the Office of Management and Budget (OMB), the Small Business Administration (SBA), and EPA pay more attention to national associations representing local government and small business than to people living and working in smaller communities. SCAS determined that EPA, OMB, and SBA put too much emphasis on gathering the opinion of Washington-based institutions that represent some small communities.

The SCAS recommended that EPA increase direct involvement of small communities in the regulatory process and reaffirm its commitment to small community consultation for any rule that has an impact on any small community.

Another recommendation was that, building on the work of EPA’s Office of Groundwater and Drinking Water, each EPA program office regularly promulgating regulations should establish a core group of small community representatives. The core group would be a group of advisors sufficiently knowledgeable to provide meaningful individual input on several rules. The program offices would be responsible for core group orientation about the specific issues associated with the rule. A consultation plan for each rule should state how these small community experts would be consulted and, if necessary, supplemented with other knowledgeable advisors during the rule making process.

Steve Wilson works for the EPA in the Congressional and Government Relations Office as EPA’s Small Community Coordinator.
Onsite Systems Management
Success in Crystal Lakes, Colorado, and Pena Blanca, New Mexico

Onsite Treatment Options-
Matching the System to the Site

Pressure Sewers-Grinder Pumps
and Septic Tank Effluent Pump
(STEP) Systems

Graywater Systems

Why Septic Systems Malfunction

An Enhanced-Performance
Septic Tank

Got an Opinion?

Who wants your opinion? The editor of the Small Flows Quarterly does, and not just as a “letter to the editor,” either. Our “Forum” column is a place where readers can share informed, well-thought-out ideas that they feel will be of value to people involved in the treatment of wastewater, both onsite and small centralized systems.

We are open to all aspects of small-flow wastewater treatment, such as technology, management, regulation, operation, and maintenance. Please send your opinions (for the Forum column, 750 to 1000 words) to the Small Flows Quarterly editor at the address on the staff box on page 2.
Looking for information about wastewater collection, treatment, and disposal? The National Small Flows Clearinghouse (NSFC) can help.

Funded by the U.S. Environmental Protection Agency, the NSFC is a nonprofit organization that assists small communities (those with populations of less than 10,000) with their wastewater-related needs. We offer a wide variety of resources about such topics as:

- septic systems and alternative onsite and community wastewater treatment technologies,
- regulations,
- operation and maintenance,
- design and monitoring,
- strategies for managing small wastewater systems, and
- public education.

The NSFC helps homeowners, local and state government officials, renters, bankers, citizens’ groups, regulators, research scientists, educators, consultants, manufacturers, operators, contractors, and other professionals. We produce two quarterly publications, *Small Flows Quarterly* and *Pipeline*, which are free by request to U.S. residents. Our Web site hosts discussion groups on wastewater issues and provides information about conferences and events across the country.

In addition, the NSFC operates a toll-free technical assistance hotline available Monday through Friday from 8:00 a.m.–5:00 p.m. Eastern Time. The NSFC provides outreach services through workshops, seminars, and conference participation. We have an inventory of more than 300 free and low-cost educational wastewater products. Contact us today for a free information packet!